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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 836

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. PROFESSIONAL PAPER April 27, 1920

BROOM-CORN EXPERIMENTS AT WOODWARD, OKLAHOMA

By

BENTON E. ROTHGEB, Assistant Agronomist in Charge of Grain-Sorghum and Broom-Corn Investigations, and JOHN B. SIEGLINGER, Assistant Agriculturist, Office of Cereal Investigations

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EXPERIMENTS WITH BROOM CORN.

The experiments[1] with broom corn at the Woodward Field Station were started in 1914. The results of five years of work are now available. While this may be too short a period from which to draw final conclusions, it is thought that the results thus far obtained are worthy of publication. Much interest is shown in the crop at this time and a large number of inquiries are being received for information with regard to varietal adaptation, the best time to sow, and the rate of seeding which will give best results in both yield and quality of brush. The results obtained at Woodward and reported herein

[1] These experiments were conducted in cooperation with the Office of Dry-Land Agriculture of the Bureau of Plant Industry. Mr. E. F. Chilcott, of that office, is superintendent of the station. Credit is hereby given him for his hearty cooperation and assistance in conducting these experiments. The senior writer was in charge of this work at the station during the seasons of 1914 and 1915. The junior writer was appointed assistant agriculturist on October 5, 1915, and conducted the experiments at the station in the seasons of 1916, 1917, and 1918.

are applicable to a greater or less extent to a large part of the southern Great Plains area.

This bulletin contains (1) a description of the district to which the results apply, (2) a description of the Woodward Field Station and the scope and methods of the experiments there conducted, and (3) the results obtained.

DESCRIPTION OF THE DISTRICT.

The section here described includes the plains of Oklahoma and Kansas, a large portion of Texas, and a small portion of southeastern Colorado and of eastern New Mexico. An outline map of this district is shown in figure 1. It includes the main districts producing the Dwarf broomcorn crop and a few localities where the Standard variety is grown. It contains at present approximately 300,000 acres of broom corn, or about 87 per cent of the entire acreage grown in this country.

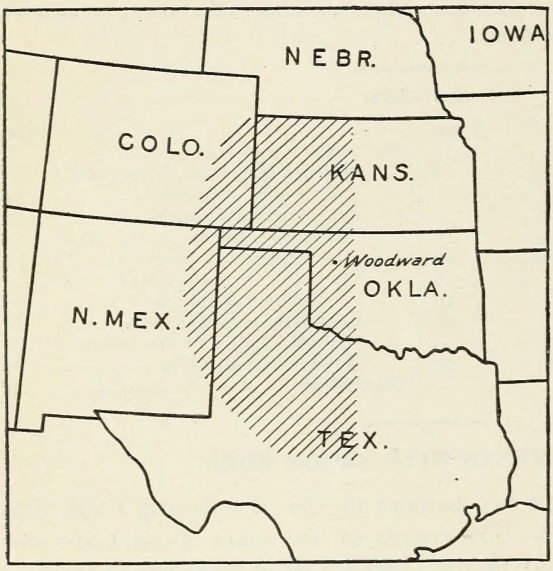

FIG. 1.—Outline map of the southern Great Plains region, showing the principal district producing the Dwarf broom-corn crop.

TOPOGRAPHY.

The section just outlined lies between the ninety-eighth meridian on the east and the one hundred and fourth on the west. It extends north to the northern boundary of Kansas and south to the thirtieth parallel in Texas. In general, it consists of broad rolling plains interrupted for the most part chiefly by the shallow valleys of the larger rivers. The altitude ranges from approximately 1,000 feet to 4,500 feet above sea level. The average annual rainfall varies considerably in different parts of the district, ranging from about 15 inches in some parts to 30 or more inches in others.

SOIL.

The soils of the area are naturally variable. Those of the eastern part have been exposed to greater precipitation and have

been eroded more than the soils of the western part. The soil types found in this extensive area vary from sand to clay, with the loams predominating in the southern and central parts of the area and silt loam in the northern. All are friable and easy to cultivate as compared with similar types under more humid conditions. They are uniformly sweet or nonacid, and under natural conditions contain from 3 to 6 per cent of organic matter. In general, low yields are due to some climatic factor or factors rather than to a lack of soil fertility.

CLIMATIC CONDITIONS.

The weather data considered herein were recorded at Woodward, Okla., during the period from 1908 to 1918, inclusive. Woodward is located centrally in the district described.

The principal climatic features which influence crop production in this section are (1) a limited annual precipitation of irregular seasonal distribution and a great loss of water due to run-off during torrential summer storms, which are quite common in some localities; (2) a relatively low atmospheric humidity; (3) a very high rate of evaporation during the summer months; (4) a wide daily range of temperature, or hot days followed by cool nights; and (5) a high average wind velocity.

Precipitation.

Precipitation and its distribution are important factors in crop production in the section under discussion. There is usually rainfall enough to grow the crop, but the distribution is not always such as to permit the best use by the crop of the moisture which falls. In such cases the crop yields are very low, and in extreme cases total failure results.

MONTHLY AND ANNUAL PRECIPITATION.

Table I shows the monthly, annual, and mean annual precipitation, in inches, at Woodward, Okla., during the 11-year period from 1908 to 1918, inclusive. The mean annual precipitation at Woodward for this 11-year period was 24 inches, of which amount 16.5 inches fell during the growing season, or from April to September, inclusive.

Table I shows a wide fluctuation in both the monthly and the annual precipitation. In April, 1909, the rainfall was 0.45 inch, and for the same month in 1915 it was 7.08 inches, or a difference of more than 6 inches between these extremes. May, June, July, August, and September each have about the same range of fluctuation as April. In the annual precipitation the extreme range is from 14 inches in 1910 to 39 inches in 1915, almost three times as great.

TABLE I.—*Monthly and annual precipitation at Woodward, Okla., during the 11-year period from 1908 to 1918, inclusive.*

[Data (in inches) furnished by the observer of the United States Weather Bureau at Woodward.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.	Mean.
1908	0.25	1.25	1.10	1.70	3.25	3.76	5.87	1.82	4.30	2.75	1.47	0	27.52	.....
1909	.05	.28	.66	.45	4.78	2.45	1.54	.29	4.88	2.95	9.54	.15	28.02	27.77
1910	.46	.22	0	1.97	.53	1.17	1.62	7.65	0	.38	0	.01	14.01	23.18
1911	0	8.09	0	.10	4.13	0	3.54	5.29	.41	.82	.52	2.90	25.80	23.84
1912	.03	2.58	2.37	1.63	1.15	3.02	3.25	2.90	3.44	.50	.06	.07	21.00	23.27
1913	.40	2.44	.54	1.11	2.08	5.31	.99	1.87	4.89	1.05	3.50	2.73	26.91	23.88
1914	.18	.51	.34	2.44	3.53	.60	.92	2.92	.82	1.99	.06	.77	15.08	22.62
1915	1.17	3.44	1.45	7.08	6.47	2.87	3.46	3.90	6.27	2.52	.56	.02	39.21	24.69
1916	1.29	.03	.92	2.01	1.74	1.64	0	1.15	2.22	1.87	.95	.38	24.20	24.64
1917	.43	.22	.34	1.93	1.39	1.89	1.33	7.00	1.90	0	.77	.18	17.38	23.91
1918	1.60	.22	1.85	2.51	4.49	2.11	1.79	.70	1.26	3.54	1.73	3.58	25.38	24.04
Average	.53	1.75	.87	2.08	3.05	3.17	2.21	3.23	2.76	1.67	1.74	.98	24.04	.....

DISTRIBUTION OF MONTHLY RAINFALL.

The total annual and seasonal precipitation, which is shown graphically in figure 2, may easily be misleading. This is due to

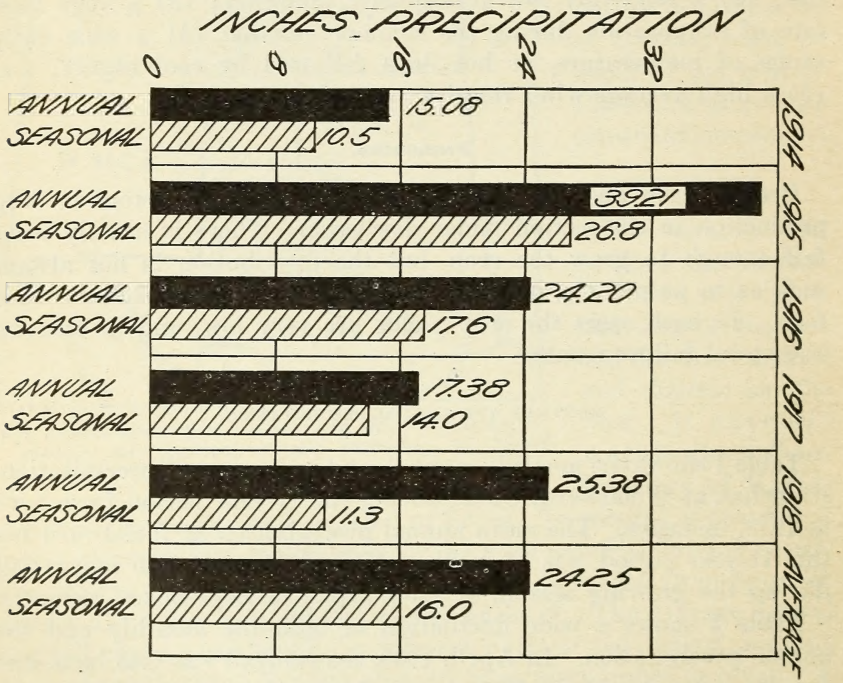

FIG. 2.—Diagram showing the annual and seasonal precipitation (April to September) and the average precipitation (in inches) at Woodward, Okla., in the 5-year period from 1914 to 1918, inclusive.

the irregular distribution of summer rainfall, to the varying quantities deposited by different showers, and to the manner in which it

falls. The nature and distribution of the rainfall will be better understood by a careful study of the data in Table II, containing the records of daily precipitation, with monthly totals, throughout the five years from 1914 to 1918, inclusive.

The annual precipitation has been sufficient to produce good broom-corn crops in almost all the years during which these experiments have been conducted, but in several seasons high yields and brush of good quality were not obtained. These poor yields are correlated in some measure with unfavorable distribution of the larger and more important rains.

Distribution may be unfavorable in several ways. Much of the annual rainfall may come within a short period either at the beginning, in the middle, or near the end of the season. The seasonal rainfall may be sufficient in quantity but poorly distributed. Some month may be unusually wet, followed by a long dry spell. Such a condition occurred in 1914, when May was wet and June and July were dry, and again in 1916, when June was wet and July was entirely without precipitation.

Still another condition may occur in which the rainfall is fairly evenly distributed in point of time and about sufficient in quantity and yet be unsuitable for crop production. This is when it occurs in light showers which do not penetrate the soil and are soon evaporated. Showers amounting to half an inch or even more may add little or no water to the soil if followed by high winds and bright sunshine, which cause rapid evaporation. The season of 1918 is a good example of this condition, as may be seen in Table II. While a number of showers fell from June to August, inclusive, only two afforded more than temporary relief to the crop.

TABLE II.—*Daily and monthly precipitation at Woodward, Okla., during the 5-year period from 1914 to 1918, inclusive.*

[Data (in inches) furnished by the observer of the United States Weather Bureau at Woodward. T=trace.]

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1914.												
1					T	T	0.04					
2				0.11	2.00	T	.07	T				
3				.25	.06		.04			T		
4					T		T	T		T		
5		0.04	T	.22	T	T		0.31				0.21
6		T		.14	T	T	T		0.31	1.25		.06
7				T	T	T	.55			.06	0.05	.02
8						T						T
9								.80				T
10					.10							T
11	0.18			.87						.29		T
12		.02							.02			
13		.08							.08	T	T	
14					T				T			
15					.36	0.57						.06
16					.03	.03			.38			T
17		.25		.22	.04		T					T
18		.12		.02	.19		T					T

TABLE II.—*Daily and monthly precipitation at Woodward, Okla., during the 5-year period from 1914 to 1918, inclusive*—Continued.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1914.												
19			T		T				T			
20					T		T					0.31
21			0.05		0.02				0.03	0.26		
22		T		T		T				T		
23		T		0.20			0.20	0.03		.13		
24			T	.02				T			T	
25											0.01	.08
26				.28	T		.02					
27	T	T		.02	.12			.71				
28					.21		T					.03
29	T		.01	.09	.01	T		.75				
30			T		.13	T		.30				
31			.28		.26			.02				
Total	0.18	0.51	.34	2.44	3.53	0.60	.92	2.92	.82	1.99	.06	.77
1915.												
1		.28			.33	.06		.12				
2			.67			.08	.57	T				
3			.18			T	.82			T		
4		.02	.37			.52	T			.02		
5		T			.09	.02						
6		T	T	1.25	1.16	.22			.06			T
7				1.96	.08			.93	T		T	
8			T	.94				1.74	T			
9			T	.04			.60	.08	.01		T	
10	.80							.13	.21		.48	
11	T									.34		
12		T					T			.07		
13		T										
14									.77	.94		
15			.07					.31		1.05		
16	.06				T	.04	T	.02	1.36	.07		
17		T		.07						.03	T	
18				.16	.12			.14				
19	T		T	.76	.95		T					
20		.89			.48	T			.17			
21		.61	T	.06	.53	T						
22		.40	.08	.14								
23						.52						
24	T			.98	1.12	.48	T					T
25	T			.16			T		1.04		.08	
26	T				1.15	T		.43	.84			T
27	T	.94			.40	T						T
28	T	.30					1.16					
29	.19		.06	.16	.04	.71						
30	.12		.02		.02	.22	.23		1.81			
31							.08				.02	
Total	1.17	3.44	1.45	7.08	6.47	2.87	3.46	3.90	6.27	2.52	.58	
1916.												
1					T				T			
2					.04							
3												
4				.51		4.71						
5				.04		.48						
6				.61								
7	T			.02		T						
8				T				.55	.55		.42	T
9						.97		.11			.08	
10		T	T			T				T		T
11									1.21	.07	T	
12	T	T		T						.24	T	
13		T			T						T	T
14			T	.12		1.48		T				T
15				.59		.09		T		1.40		T
16												
17					.31	1.00						T
18	T					.38			T	T		
19	T									T		
20					T	.17						
21	.30				T			.18				.18
22		.03						T			.45	T
23			T						.44			
24	T					2.36				.10		
25	.89		T	.12					.02	.02		
26	.06		.38			T		.25				T
27	.04	T			.66						T	
28	T				.73							

TABLE II.—*Daily and monthly precipitation at Woodward, Okla., during the 5-year period from 1914 to 1918, inclusive*—Continued.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1916.												
29	T	T	.....	.....	.....	.....	.....	T	.....	0.04	.....	.....
30	T	.....	.....	T	.....	.....	.....	0.06	.....	.....	.....	.....
31	T	.....	0.54	.....	.....	.....	T	.....	.....	.....	.....	0.2
Total	1.29	0.03	.92	2.01	1.74	11.64	.....	1.15	2.22	1.87	0.95	.38
1917.												
1	.....	.....	.....	.....	.....	.....	.37	.19	.....	.....	.....	.....
2	.....	.....	T	.....	.....	.26	.09	.....	.02	T	.....	.....
3	.....	.....	T	.....	T	.....	.10	.....	.....	.....	.....	.....
4	T	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
5	T	.....	.....	.....	.....	.....	T	T	.....	.....	.....	.....
6	.....	.....	.....	.....	T	.....	.....	.01	.....	.....	.....	.....
7	.....	.....	.....	.....	.....	.....	.....	1.72	.....	.....	.....	.....
8	.....	.....	.....	.....	.....	.02	.....	.12	.....	T	.....	.18
9	.....	.....	.....	.....	T	.....	.....	.01	.....	.....	.....	.....
10	.....	.....	.....	.....	.07	.....	.....	.....	.49	.....	.....	.....
11	.....	.....	.....	.....	.10	.....	.02	.50	.....	.....	.....	.....
12	.....	.....	.....	.28	.....	.....	.....	.66	T	.....	.....	.....
13	T	.....	.28	.04	T	.....	.....	.86	T	.....	.....	.....
14	.....	.....	.06	T	.45	.....	.....	.02	T	.....	.....	.....
15	.16	.22	.....	.22	.....	.....	T	.....	T	.....	.....	.....
16	.03	.....	.....	.....	T	.....	T	1.20	.57	.....	.....	.....
17	.....	.....	.....	.....	.....	.....	.....	.10	.....	T	.65	.....
18	.....	.....	.....	.....	.....	.....	.35	.....	.42	.....	.10	.....
19	.....	.....	.....	.60	T	T	.37	.....	.32	.....	T	.....
20	.....	.....	.....	.....	.43	.17	T	.....	.....	.....	.....	.....
21	.24	.....	.....	.....	T	1.20	.....	.....	.....	.....	.....	.....
22	T	.....	.....	.....	T	.....	T	.....	.....	.....	.....	.....
23	T	.....	.....	.....	.....	.19	.03	.55	.....	.....	.....	.....
24	.....	.....	.....	.....	.....	T	.....	.....	.....	.....	.....	.....
25	.....	.....	.....	T	.08	.....	.....	.07	.....	.....	.....	T
26	.....	.....	T	.03	.....	.....	.....	.....	.08	.....	.....	.....
27	.....	.....	.....	.....	.26	.....	.....	.....	T	.....	.....	.....
28	.....	.....	.....	.14	.....	.....	.....	.66	.....	.....	.02	.....
29	.....	.....	.....	.....	.....	.05	.....	.33	.....	T	.....	.....
30	.....	.....	.....	.62	.....	.....	.....	.....	.....	.....	.....	.....
Total	.43	.22	.34	1.93	1.39	1.89	1.33	7.00	1.90	T	.77	.18
1918.												
1	.....	.....	.....	.....	.....	T	.....	.....	T	.....	.....	.....
2	.....	.....	.10	.....	.....	.....	.06	.....	.04	.....	T	.....
3	.....	.....	1.04	.....	.....	.....	.....	.....	.09	.....	.....	.....
4	.....	.....	.06	.....	T	.....	.....	.....	.72	.....	.....	.....
5	.....	.....	.....	.....	T	T	.....	.....	.01	.....	.....	.....
6	.....	.....	.....	.36	.04	.....	.....	.....	.13	.....	T	.....
7	.....	.....	.....	.....	.....	.51	.....	.....	.....	.....	.83	.....
8	.....	.....	.....	.....	.....	.88	.....	.04	.....	.....	.....	.....
9	.....	T	.....	.....	T	.02	.....	T	T	T	.....	.....
10	.09	.....	.....	.....	.....	.....	T	T	.....	.....	.....	.....
11	.38	.04	.....	.....	.....	.....	T	.....	.....	.....	.....	.....
12	.....	.07	.....	.....	.41	.....	.....	.....	.....	.....	.....	.24
13	.....	.....	.....	T	.....	.....	T	.....	.....	.....	.....	T
14	T	.....	.....	.10	.....	.....	.....	T	.....	.....	T	.....
15	.....	.....	.....	1.36	.....	.....	.32	.....	T	.....	T	.....
16	.93	.....	.....	.....	.....	.....	1.22	T	.10	.....	T	.52
17	.....	.....	.....	T	.17	.....	.04	T	.....	.....	.05	.10
18	.....	.....	.....	.13	.....	.....	T	.....	.....	.....	.....	.36
19	.06	.....	.....	.41	.....	.....	T	.....	.....	.44	.....	.86
20	.....	.....	.....	.12	.....	.....	.....	.....	.....	.02	.....	.....
21	.....	.....	.....	.03	.....	.....	.....	.....	.....	.....	.....	.....
22	.....	.....	T	.....	.....	.....	.06	T	.....	1.65	.....	.....
23	.....	.....	.....	.....	.07	.....	.09	.51	.....	.22	T	1.20
24	.....	.....	.....	.....	.....	.....	T	.01	.....	T	.85	.20
25	.....	.....	.....	.....	.....	.....	.....	.....	.12	.....	.....	.....
26	.....	.....	.....	.....	.26	.....	.....	.....	.05	.75	.....	.....
27	T	T	.....	.....	.08	.21	.....	.....	.....	.46	T	.....
28	.14	.11	.25	T	.87	.....	.....	.....	.....	.....	.....	.....
29	.....	.....	.40	.....	2.32	.13	T	.....	.....	.....	.....	.....
30	.....	.....	.....	.....	.....	.36	.....	.14	.....	.....	.....	.....
31	.....	.....	.....	.....	.27	.....	.....	.....	.....	.....	.....	.10
Total	1.60	.22	1.85	2.51	4.49	2.11	1.79	.70	1.26	3.54	1.73	3.58

Humidity.

The atmospheric humidity of this section is low on the average. It decreases and the wind velocity increases from the central part of Oklahoma westward. The usually low humidity at Woodward no doubt plays an important part in influencing transpiration from the growing crops.

TABLE III.—*Monthly climatic data, covering temperature and wind movement, recorded at the Woodward (Okla.) Field Station in the six months, April to September, inclusive, of each year during the 5-year period from 1914 to 1918, inclusive.*

Season and month	Temperature.					Wind.			
	Mean.	Maximum.		Minimum.		Prevailing direction.	Monthly movement.	Highest day.	
		Reading.	Date.	Reading.	Date.			Movement.	Date.
	°F.			°F.			Miles.	Miles.	
Season of 1914:									
April	57	96	16	24	8	N.	7,344	440	21
May	65	92	10	40	a 8	S.	6,845	400	10
June	80	103	28	52	28	S.	7,920	463	7
July	81	106	a29	57	9	S.	4,613	298	22
August	79	101	20	60	a11	S.	4,836	316	23
September	74	100	10	40	30	S.	5,688	331	13
Season of 1915:									
April	61	92	28	28	a 1	S.	6,768	481	4
May	63	92	13	37	7	E.	5,952	413	25
June	72	100	20	44	8	E.	5,544	351	11
July	78	99	12	50	5	S.	5,580	342	7
August	73	99	17	41	31	E.	3,050	189	7
September	72	99	10	46	27	S.	4,248	302	13
Season of 1916:									
April	53	88	a11	20	9	SW.	6,624	445	19
May	68	105	7	32	1	SW.	6,770	446	10
June	73	101	1	52	6	E.	5,976	478	22
July	80	103	19	55	a 7	S.	4,241	235	2
August	81	104	a 3	46	28	SW.	5,506	287	10
September	70	98	12	31	29	SW.	5,904	381	27
Season of 1917:									
April	55	91	22	23	2	NW.	8,237	507	16
May	60	98	17	30	8	SW.	6,653	475	17
June	76	109	12	41	a 2	S.	6,720	495	11
July	83	108	13	56	12	SW.	5,597	300	29
August	76	100	4	45	29	SE.	3,774	234	5
September	71	102	7	36	27	SE.	3,257	247	25
Season of 1918:									
April	51	82	1	29	a10	NE.	5,678	360	14
May	69	99	8	34	1	SE.-SW.	8,129	462	19
June	79	106	24	58	a 1	SW.	4,649	295	30
July	80	103	15	53	1	SW.	4,745	420	4
August	84	105	a 3	50	31	SW.	4,680	262	6
September	66	102	15	34	a 20	SW.	3,874	266	24

a Other dates also.

Wind.

Monthly data on wind are shown with other data in Table III for the crop season (April to September) in the 5-year period from 1914 to 1918, inclusive. The wind velocity for the season averages high. Some days are calm; then there are other days when the wind moves at a very high velocity. The highest total movement for one day during that period was 507 miles, which occurred on April 16, 1917. This is an average of more than 21 miles an hour

for the entire day. Such high winds may cause great damage either by covering up the young plants, by cutting them off with moving particles of soil, or by blowing down the crop when it is approaching maturity.

Temperature.

The daily range in temperature is large. In summer the days are warm to hot, but the nights usually are cool. The data on mean, maximum, and minimum temperatures and the dates, by months, for the season (April to September) in the 5-year period from 1914 to 1918, inclusive, are given in Table III, which also contains data on wind movement.

The temperature in winter seldom reaches zero, but occasionally even lower temperatures occur. In summer the temperature reaches the 100° F. mark and above quite frequently. The maximum temperature in this 5-year period, 109° F., was recorded on several dates in June, 1917. The average date of the last spring frost is April 11, and that of the first fall frost, October 25, leaving an average frost-free period of 196 days.

Evaporation.

In the district here described the loss of moisture by evaporation is very great. The chief factors that influence evaporation are precipitation, wind, and temperature. The maximum evaporation naturally occurs in periods of high temperatures, low rainfall, and strong winds.

TABLE IV.—*Monthly seasonal and average monthly precipitation and evaporation at the Woodward (Okla.) Field Station during the six months from April to September, inclusive, in the 5-year period from 1914 to 1918, inclusive.*

[Data (in inches) furnished by the Office of Biophysical Investigations, Bureau of Plant Industry.]

Year.	April.		May.		June.		July.		August.		September.		Total.	
	Precipitation.	Evaporation.	Precipitation.	Evaporation.	Precipitation.	Evaporation.	Precipitation.	Evaporation.	Precipitation.	Evaporation.	Precipitation.	Evaporation.	Precipitation.	Evaporation.
1914	1.7	6.8	3.2	6.2	0.6	11.3	1.9	10.9	2.6	8.9	0.6	8.4	10.5	52.6
1915	6.5	6.0	5.3	6.7	2.4	6.6	3.1	10.0	3.6	6.5	5.7	5.8	26.8	41.7
1916	2.3	6.0	1.7	9.8	10.3	7.7	0	10.4	1.0	11.2	2.3	7.5	17.6	52.6
1917	1 6	7.2	1.0	7.0	1.4	11.3	1.1	11.7	6.9	7.4	2.0	5.0	14.0	49.6
1918	2 2	5.0	4.0	9.3	1.9	8.7	.7	10.1	1.3	11.0	1.2	5.8	11.3	49.9
Average	2.9	6.2	3.0	7.8	3.3	9.1	1.4	10.6	3.1	8.0	2.4	6.5	16.0	4..3

Table IV contains a comparison of the monthly precipitation and evaporation records made at the Woodward Field Station during the six months from April to September in each year of the 5-year period from 1914 to 1918, inclusive. The evaporation measured is

from the free water surface of a tank 8 feet in diameter. The evaporation was more than three times as great as the precipitation during that period. The maximum monthly evaporation, 11.7 inches, in this 5-year period, occurred in July, 1917. During that same month the precipitation amounted to only 1.1 inches. The 5-year average evaporation for July was 10.6 inches, and that of the precipitation 1.4 inches. The averages for August are 8 inches of evaporation and 3.1 inches of precipitation. Such high evaporation and low precipitation have a bad effect on plant growth and are contributing causes to certain unfavorable crop results in various years.

THE WOODWARD FIELD STATION.

The Woodward Field Station, located 1 mile southwest of the main part of Woodward, Okla., was established by the Office of Dry-Land Agriculture during the autumn of 1913, and the first crop was produced the following season. The farm consists of 160 acres of bench land. Most of the soil at the station is a light phase of sandy loam which is classified as Canadian sandy loam. Some soil blowing has occurred at the station but has never been serious.

Woodward is centrally located in the western broom-corn area, and conditions are fairly representative of the transition belt which extends north and south between the high plains on the west and the prairie region to the east. The principal crops of the surrounding country are milo, kafir, broom corn, and winter wheat, with some corn and alfalfa grown on bottom lands. The results of the experiments with broom corn at this station should be applicable to the greater part of the western broom-corn area.

THE BROOM CORNS.

Broom corn is a specialized sorghum, closely related to sweet sorghum. It consists of two rather distinct groups of varieties. These react differently to environmental conditions and therefore give different results. To understand these results it is necessary to know the characters by which the groups differ from each other.

CLASSIFICATION.

The two groups of broom corn differ mainly in the height of the plants, in the tenacity of the attachment of the peduncle to the upper node, and in the length and texture of the brush.

Standard broom corn grows to a height of 8 to 10 feet under the conditions obtaining at the Woodward Field Station. Under more favorable conditions farther east it reaches a height of 12 to 15 feet. The leaves vary from 9 to 11 in number. The heads range in length from 18 to 24 or more inches. They are well exserted from the boot

or upper leaf sheath and firmly attached to the upper node, which makes necessary the use of a knife in harvesting the brush. The fiber is coarse, but usually round and pliable.

Dwarf broom corns range in height from 3.5 to 6 feet, with short internodes. The leaves are narrow, dark green, and from 10 to 13 in number. The heads range in length from 15 to 22 or more inches under quite favorable growing conditions, but remain from one-half to one-third inclosed in the upper sheath. They are not as firmly attached to the upper node, which makes harvesting possible without the aid of a knife by pulling or jerking the heads from the standing stalks.

EXPERIMENTAL CONDITIONS.

In order to gain a better understanding of the experimental results obtained from the varieties included in the different experiments, it is necessary to know the methods of obtaining the data recorded and the conditions prevailing each season.

Methods Employed.

The methods employed in regard to the size and arrangement of the plats, the crop rotation practiced on the experimental area, the date on which the varietal experiment was sown each year, and the method of collecting certain agronomic data are explained in the following paragraphs.

SIZE AND ARRANGEMENT OF PLATS.

The land used in these experiments is divided into series which are 8 rods wide, extending the whole length of the field from north to south. These series are separated by roads 20 feet wide. The rows of broom corn extend across the series from east to west and are spaced 3.5 feet apart. Thus, each row occupies a space 8 rods long and 3.5 feet wide and represents approximately one-hundredth of an acre. Seeding is begun at either end of the series and continued until the entire series is finished. No alleys are left between the varieties, so there is no border effect except at the ends of the rows, where they border on the roads. Each variety usually occupied 10 rows, or a tenth of an acre. In sowing the varieties the rows were made longer than 132 feet, extending several feet into the roadway at both ends. When the plants had attained a height of 12 to 15 inches the ends of the rows were trimmed to the proper limits.

CROP ROTATION PRACTICED.

It has not been practicable to follow a definite system of crop rotation in these experiments, because the land available for this work was all in sod the first year (1914), and only enough could be pre-

pared for immediate use. The pressure of other work prevented breaking new sod in time for the 1915 crop, so the same land was used as in 1914. Later in the season more sod was broken. This sod land was fallowed and used for the 1916 crop. In 1917 the varietal experiment followed the same crop, and the other experiments followed cowpeas. In 1918 the varietal experiment followed cotton, and the other experiments followed broom corn.

METHOD OF SEEDING.

A 2-row combined corn and cotton drill fitted with sorghum plates was used for sowing the crop from 1914 to 1916, inclusive. Since then a 2-row drill fitted with a special plate, which is thinner than the ordinary sorghum plate, has been used. This plate contains 36 holes, each three-sixteenths of an inch in diameter. The feed was run on high gear, which drops at intervals of about 3 inches. It was desired to have only one kernel dropped at a time, and the above-described plate was designed to accomplish that end; but in many cases two and occasionally three kernels were dropped, because the kernels vary in size.

Broom-corn seed usually remains inclosed in the glumes or hulls, but some seed is dehulled by the thrasher. Seeds free from glumes will pass through a much smaller hole than the seed remaining in the hulls. This makes a drop of a single kernel each time impossible where the dehulled seeds are mixed and the holes in the plates are large enough to drop seeds covered with a hull.

Seeding was done at a rate heavy enough to insure a thick stand under normal conditions, with the idea of obtaining a stand sufficient for these experiments if the conditions were unfavorable. When the plants were from 6 to 10 inches high the plats were thinned by hand to the stands desired in the different experiments.

DATES WHEN THE CROPS WERE SOWN.

The dates on which the crops in the varietal, rate-of-seeding, and spacing experiments were sown each year are as follows: In 1914, all three experiments were sown on May 14. In 1915 the varietal and the rate-of-seeding experiments were sown on May 25 and the spacing experiment on the following day. In 1916 the spacing experiment was sown on May 19 and the other two on May 22. In 1917 the spacing experiment was sown on May 18 and the others on May 24. In 1918 the varietal and rate-of-seeding experiments were sown on May 27 and the spacing experiment on June 3.

METHODS OF COLLECTING DATA.

The data on plant and stalk spaces and on the occurrence of suckers and heads were obtained by actual counts of the plants,

stalks, and heads in all the rows of each variety for which such data are presented. The percentage of suckers is determined by dividing the difference between the number of stalks and the number of plants by the number of stalks. The percentage of headed stalks is the number of stalks that bore heads divided by the total number of stalks in the plat. The growing period as given here is the total time elapsing from seeding until the brush is harvested, usually when in the dough stage. The vegetative period is the time from seeding until the heads appear. If growing conditions are unfavorable and heading is progressing slowly and unevenly, this period is prolonged but counted as ended when heads cease to appear. The fruiting period is the completion of the vegetative period or the time from the appearance of the heads until the brush is considered ready to harvest.

The height of the plants is the average of several measurements made at different points in the plat. The heads are included in these measurements and considered as standing erect, though most of them droop, which gives the stalks the appearance of a lower height.

The standard varieties are harvested by tabling the stalks so that the heads are brought within easy reach. Then the heads are cut off with a jackknife, leaving about 6 inches of stem with the head. The Acme and Dwarf varieties are harvested by pulling or jerking the heads from the standing stalks. The heads are taken at once to the curing shed and thrashed. Then the thrashed brush is placed in layers, about 3 inches thick, on shelves in racks to cure. After the brush is cured, which requires about two weeks, depending somewhat upon the weather conditions, it is graded. This is done by sorting by hand the good brush from the poor. Each lot is then weighed and the acre yields are computed therefrom. The combined weight of the two grades is the total yield per acre.

Brush with long, round, straight fiber without heavy center stems is graded good quality, and short, spiky brush with large center stems and that with crooked brush or coarse, flat fiber is graded poor quality. Heads with fiber of good and poor quality are shown in figure 3.

The length of the brush in each grade is the average length of 10 heads picked at random from each lot after it is graded.

The percentage of good brush is the weight of that grade divided by the combined weight of both grades, or the total yield of the plat.

Environing Conditions.

A brief summary of the environing conditions during the 5-year period from 1914 to 1918, inclusive, is given to aid in the interpretation of the results obtained during that period.

The season of 1914 was not favorable to high yields. The rainfall for the first four months of the year was below normal, which left the soil without much stored moisture. One good soaking rain

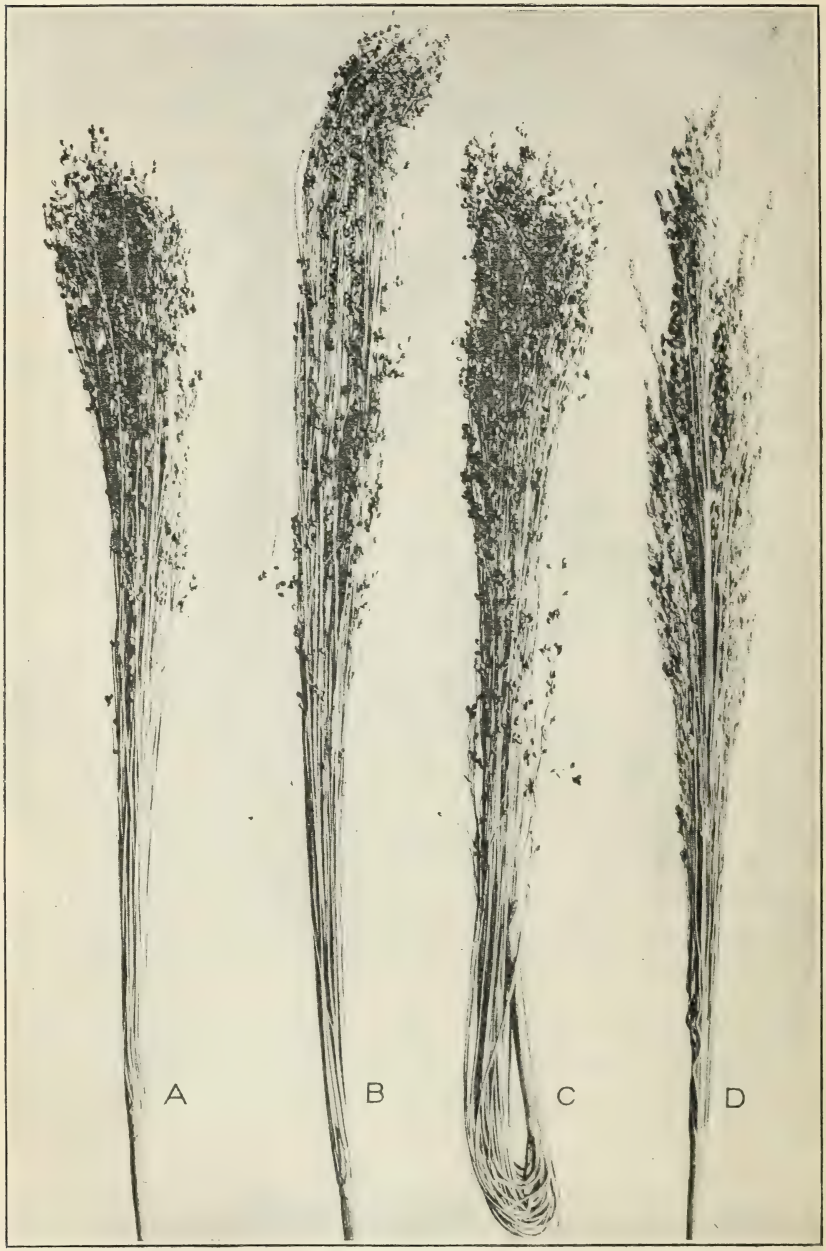

FIG. 3.—Heads of broom corn: (*A*) Good type, round fiber; (*B*) coarse, flat fiber; (*C*) crooked head; and (*D*) poor, short fiber and a large central stem.

of 1.96 inches occurred on the first day of May. There were 13 light showers, well distributed throughout the remainder of the month, but none of these was sufficient to furnish stored moisture for future use. June was extremely dry, with only one rain of 0.61 inch, which fell on the 15th of the month. The next rainfall of value did not come until July 6. During the remainder of July there was only one rain. The rainfall for August was below normal and over half of it fell in the last five days of the month, which was too late to benefit the crop, which had been sown the middle of May.

The season of 1915 was extremely wet. The rainfall for each of the first 10 months of the year was above normal. During the growing season there was no time that the crop lacked moisture. This resulted in unusually high yields in all varieties.

The year 1916 was variable and unfavorable. The total precipitation, which was about normal, was quite unevenly distributed. The rainfall in April was normal, but for May it was only about half of the normal. The precipitation for June amounted to 11.64 inches, which is about 8 inches above the normal for that month. More than 5 inches of this fell on the 4th and 5th, but the remainder was fairly evenly distributed throughout the rest of the month. July was bone dry; August was short by nearly two-thirds and September by almost one-third of the normal supply. Crops so seeded that the critical growing stage of the plants did not occur in a droughty period made fair to good yields, but otherwise both yield and quality of brush were affected.

The season of 1917 was not favorable to the production of broom corn of good quality. The rainfall for May, June, July, and September was considerably below the normal of those months, while the rainfall for August was 7 inches, which was nearly half of the total precipitation for the entire year, or 3.5 inches above the normal for that month.

The crop season of 1918 was the poorest in the 5-year period under consideration. The rainfall in April and May was about normal and fairly well distributed, which furnished moisture sufficient to start the crop in good condition; but June was dry, and July was drier still. The rainfall for August amounted to only seven-tenths of an inch, and this fell on four different days, which made it of little value to the crop. The temperature for the three months, June, July, and August, was high, as was also the evaporation. These conditions, together with the law rainfall, made growth practically impossible at times, which resulted in the lowest yields in five years.

VARIETAL EXPERIMENTS.

The objects of the varietal experiments were to determine the adaptation and value of the different groups of broom corn and the best varieties in each group.

The results obtained from all the lots and selections of all varieties included in these experiments in any or all of the five years from 1914 to 1918, inclusive, are presented in the tables that follow. All the agronomic data that are available, so far as they serve to show the comparative response of the different varieties to environing conditions each season, are presented.

The data in the tables include not only the yields, therefore, but the row space occupied by each plant and each stalk; the length in days of the vegetative and fruiting periods and of the total growing period; the percentage of suckers and of stalks headed; and the height of the plants. The yield (in pounds) of good and poor brush and the total yield of brush per acre are shown. The average length of the brush of each quality and the percentage of good brush in the total yield are also given.

The tabulated data show clearly that the Dwarf varieties of broom corn outyield the Standard varieties under such conditions as exist at Woodward, Okla. The Dwarf varieties evidently require less water and therefore are better adapted to the conditions obtaining in the district described than the Standard varieties.

STANDARD BROOM CORN.

The groups of broom corn have been described previously. Many varietal names are applied to each group; but these are not significant in most, if not all, cases, as they do not represent distinct varieties. Some of the names applied to Standard broom corn are: Australian, California Golden, Chinese Evergreen, Early Longbrush Evergreen, Evergreen, Imperial Evergreen, Improved Evergreen, Missouri Evergreen, and Tennessee Evergreen. In many cases these are local names. The grower should know that he has seed of high germination, selected from brush of good quality. The manufacturer is not particularly interested in the name applied to the brush. What he wants to know is the quality of the brush he is buying. This he can not determine by the name, but instead must see the brush itself.

The results obtained with the Standard variety in the varietal experiment are shown in Tables V and VIII. From 1914 to 1916, inclusive, one plat only of this variety was grown each year. The source of that variety (C. I. No. 556) is supposed to be Florence, Italy. The stock seed used in the experimental work was obtained by the senior writer in 1914 from Lindsay, Okla., the original seed having been imported two years previously. The field at Lindsay

from which this seed was selected was of uniform height and produced a crop of good brush. The fiber was round, pliable, of medium size, and of uniform length.

In 1917 two more strains (C. I. Nos. 580 and 588) were included in the experiment. These were obtained in the spring of 1915 and grown for two years in 8-rod rows before being increased to tenth-acre plats. The former (C. I. No. 580) was obtained from a seed company in Houston, Tex., under the name "California Golden Dwarf," and the latter (C. I. No. 588) from a seed firm in New York, under the name "Evergreen." These strains are early, and for that reason were thought to be of probable value.

The vegetative period for C. I. No. 556, shown in Table V, ranges from 73 to 80 days for all years except 1917. In that year it was prolonged to 112 days, which was due to droughty weather conditions during the vegetative period. For the other two strains the vegetative periods in that same year were 95 and 100 days, respectively, which are 17 and 12 days shorter for these strains than for C. I. No. 556. The fruiting period usually occupies from 17 to 20 days, depending upon growing conditions. These early strains required less time than C. I. No. 556 by 9 and 7 days in 1917, and the fruiting period of the one grown in 1918 was shorter by 5 days. The other strain (C. I. No. 588) was discarded after one year. It was not as early as the one which is retained, and while the brush was of a greater average length the quality was not as good. The most objectionable feature was the construction of the head. Almost without exception the heads had a rachis or central stem from 3 to 4 inches in length.

The average row space per plant in the 5-year period ranged from 5.8 inches in 1915 to 8.6 inches in 1918. The plats were thinned by hand each year to approximate a stand of one plant to 6 inches of row space, as that appears to be about the right rate for the best results under Woodward conditions. The stalk space does not differ materially from the plant space, as the percentage of suckers is quite small. In 1914 and 1915 the suckers amounted to less than 1 per cent, and they were as much as 20 per cent in only one year. This occurred in 1918 in one variety, though the average for the two strains that year was only 14.9 per cent.

The yield per acre of brush is recorded in pounds. The yield of good quality is recorded first, then that of poor quality, and lastly the total yield, which is the combined weight of both qualities. The highest total yield was obtained in 1915, which was the most favorable season for high production in the 5-year period. But the percentage of good brush was lower in that year than in any other. This is natural, as seasonal conditions favorable to rapid growth are

conducive to the development of coarse, kinky, or burly fiber and crooked heads. Table VIII shows the annual yields of all lots of broom corn included in this experiment, together with their average yields in periods of varying length.

TABLE V.—*Agronomic data for Standard broom corn grown in varietal experiments at the Woodward (Okla.) Field Station during the 5-year period from 1914 to 1918, inclusive.*

Year and variety.	Row space (inches).		Length of period (days).			Percentage of—		Height of plants (feet).	Yield of brush per acre (pounds).			Length of brush (inches).		Percentage of good brush.
	Plants.	Stalks.	Vegetative.	Fruiting.	Total.	Suckers.	Headed stalks.		Good.	Poor.	Total.	Good.	Poor.	
Season of 1914:														
C. I. No. 556	6.7	6.7	77	17	94	0	79.6	6.5	225	75	300	22.0	14.0	75.0
Season of 1915:														
C. I. No. 556	5.8	5.8	80	21	101	0	94.4	8.3	440	235	675	22.0	22.0	65.2
Season of 1916:														
C. I. No. 556	8.0	7.5	73	18	91	6.6	86.1	7.0	366	39	405	22.0	15.0	90.4
Season of 1917:														
C. I. No. 556	7.0	6.5	112	20	132	6.0	80.8	7.0	350	31	381	18.5	16.5	91.8
C. I. No. 580	6.6	5.8	95	11	106	12.2	84.1	6.5	160	45	205	12.5	10.0	78.0
C. I. No. 588	6.5	6.3	100	13	113	3.0	79.0	7.0	200	33	233	14.5	12.0	85.7
Average	6.7	6.2	102	15	117	7.1	81.3	6.8	237	36	273	15.2	12.8	83.2
Season of 1918:														
C. I. No. 556	8.6	6.9	78	17	95	20.3	73.3	6.0	275	30	305	18.5	13.5	90.1
C. I. No. 580	6.7	6.0	63	12	75	9.6	83.7	5.5	356	22	378	17.5	12.5	94.1
Average	7.6	6.4	70	15	85	14.9	78.5	5.7	315	26	341	18.0	13.0	92.1

ACME BROOM CORN.

The Acme broom corn was developed from a selection made in a field of Standard broom corn by Mr. A. H. Leidigh, at Channing, Tex., in 1906. It resembles the Standard variety in the length and texture of the brush and the Dwarf in the height of the stalk. The peduncle, or main stem, is less firmly attached to the upper node, or joint, than it is in the Standard broom corn. This makes it possible to harvest it in the same way as the Dwarf variety. The Acme requires less water than the Standard, and it produces a brush of good length and quality under the average seasonal conditions obtaining in the southern Great Plains. These characters make it adapted to conditions in that section of the United States. It is now being grown there commercially to a limited extent. Plants of this variety are shown in figure 4.

The results with the Acme broom corn obtained in the varietal experiment conducted at the Woodward Field Station during the 5-year period from 1914 to 1918, inclusive, are shown in Tables VI and VIII. It will be noted in Table VI that in the 5-year period the row space per plant ranged from a minimum of 5.5 inches in 1915

to a maximum of 8.7 inches in 1916, with an average of 7.3 inches for the whole period. This is approximately the same stand as that of the other varieties, which makes comparison possible. This variety requires about 90 days to mature under average conditions. This time may be either lengthened or shortened by growing conditions; it was prolonged to 115 days in 1917, while it was only 84 days in 1918. Droughty weather when the crop is approaching the heading stage, changed to favorable growing conditions by rain during that stage, will prolong the vegetative period and make heading irregular, though the percentage of stalks headed may be high, as in 1917,

FIG. 4.—Plants of Acme broom corn (C. I. No. 243).

when 97.5 per cent of all stalks headed. The vegetative period may be shortened by the reversal of growing conditions from favorable to unfavorable just as the plants are approaching the heading stage. In such cases none except the early stalks produce heads. This results in the shortening of the growing period and in a low percentage of stalks headed, as was the case in 1918, when the crop required only 84 days to mature and produced only 66.6 per cent of heads.

The average height of the plants ranged from 3.5 feet in 1918, a very dry season, to 5.5 feet in each of the years 1915 and 1917, when seasonal conditions were more favorable. The plants are uniform in height, and the height compares favorably with the best strains of the Dwarf broom corn.

The yield and percentage of good brush vary with the season. However, a low yield of brush does not necessarily mean a small percentage of good quality. In 1918 the yield of good brush was at the rate of 283 pounds to the acre, which was 91.1 per cent of the total crop. In 1915 the yield of good brush was 600 pounds per acre, which was only 79.4 per cent of the total yield. The acre yield of good brush ranged from 283 pounds in 1918 to 600 pounds in 1915, with an average yield of 392 pounds in the 5-year period, which is an average of 88.5 per cent of the total brush produced in that period. The annual and the average yields are shown in Table VIII, where it will be noted that this variety ranked second in the 2-year average and tied with one Dwarf strain for first place in the 5-year average. In percentage of good brush it ranks first. This is shown graphically in figure 7.

TABLE VI.—*Agronomic data for Acme broom corn grown in varietal experiments at the Woodward (Okla.) Field Station during the 5-year period from 1914 to 1918, inclusive.*

Year and variety.	Row space (inches).		Length of period (days).			Percentage of—		Height of plants (feet).	Yield of brush per acre (pounds).			Length of brush (inches).		Percentage of good brush.
	Plants.	Stalks.	Vegetative.	Fruiting.	Total.	Suckers.	Headed stalks.		Good.	Poor.	Total.	Good.	Poor.	
Season of 1914:														
C. I. No. 243	7.7	7.7	73	17	90	0	87.4	4.0	305	20	325	22.0	14.0	93.8
Season of 1915:														
C. I. No. 243	5.5	5.2	77	18	95	4.8	93.0	5.5	600	155	755	23.0	23.0	79.4
Season of 1916:														
C. I. No. 243	8.7	6.6	70	17	87	24.1	83.6	3.8	378	55	433	18.5	16.0	87.2
Season of 1917:														
C. I. No. 243	7.1	6.5	107	8	115	8.7	97.5	5.5	394	39	433	17.0	13.0	91.0
Season of 1918:														
C. I. No. 243	7.5	5.8	69	15	84	22.6	66.6	3.5	283	28	311	17.5	15.5	91.1
Average	7.3	6.4	79.2	15	94.2	12.0	85.6	4.5	392	59.4	451	19.6	16.3	88.2

DWARF BROOM CORNS.

Dwarf broom corn came into prominence during the early nineties, owing to its adaptation to dry-land conditions. Since then the center of production of the broom-corn crop has moved from Illinois westward into Oklahoma. Most of the crop grown in Oklahoma and adjacent States is of the Dwarf variety except in the Lindsay district of Oklahoma, which includes the Washita bottom lands in Garvin, Grady, and McClain counties. As in the case of the Standard variety, many names are applied to the Dwarf broom corn. Some of the most common of these are California Golden Dwarf, Dwarf, Dwarf Evergreen, Evergreen Dwarf, Japanese Dwarf, and

Oklahoma Dwarf. These names are mostly local and do not represent different varieties.

The Dwarf broom corn used in the varietal experiment included three different lots in the first three years, from 1914 to 1916, inclusive. In 1917 three more lots were added, making a total of six grown in that year. One was added in 1918, which made seven for that year. In all, a total of seven different lots and 22 plats were grown in the 5-year period from 1914 to 1918, inclusive. These lots were obtained from different sources, most of them widely separated.

C. I. No. 442 was obtained from a grower at Sterling, Kan., in 1911, and has been grown at the Amarillo (Tex.) Field Station since

FIG. 5.—Plants of Dwarf broom corn (C. I. No. 442).

that time. Plants of this strain are shown in figure 5. C. I. No. 535 is the result of a selection made by the senior writer in 1912 from a crop grown at the Amarillo station that year from bulk seed obtained from a grower near Amarillo, Tex. The crop from which this selection was made was evidently a mixture of Standard and Dwarf varieties, as it was quite variable in height and type of brush.

C. I. No. 557 was obtained from a grower at Elk City, Okla., in 1914. He had been growing this strain in large quantities for a number of years, distributing the seed commercially under the name Evergreen Dwarf. It is a good variety, well adapted to dry lands, which produce a high yield of good brush under average conditions.

C. I. Nos. 559, 564, 595, and 597 were obtained from different seed companies and grown in 8-rod rows at the Woodward Field Station for two or three years before being included in the varietal experiment.

The agronomic data for Dwarf broom corn are shown in Table VII, while the annual and average acre yields are shown in Table VIII, where comparisons with the Standard and Acme varieties are made.

The row space per plant in the different lots does not vary more than about an inch in any one year, while the average row space for all lots in the same year ranges from 6.3 inches in 1915 to 8.6 inches in 1916. From this standpoint the Dwarf varieties are directly comparable with the other varieties used in the experiment.

The total growing period of the three lots grown during the entire 5-year period ranged from 84 days in 1918 to 114 days in 1917, with an average of 94 days for the period. This is the same average period as for the Acme, but 9 days less than was required by the Standard, which was 103 days in the same period. The average proportion of suckers in these same three lots is 15.5 per cent, which is 3.5 per cent greater than for Acme and about three times as high as for the Standard, C. I. No. 556.

In height C. I. No. 442 is consistently lower than any of the other lots. Its height ranged from 2.3 feet in 1918 to 4.3 feet in 1915. While the other two lots are of practically the same height in most years, they show a difference of 6 inches in 1917, each reaching its maximum of 5 and 5.5 feet, respectively, in that year. The new lots added in 1917 compare favorably in height with the two just mentioned.

The average yield of good brush by the three lots grown during the entire 5-year period ranged from 240 pounds in 1918 to 615 pounds in 1915. The average total yield produced in these same two years was 278 and 752 pounds, respectively. The yield of good brush was 85.8 per cent and 82.2 per cent of the total yield. The higher percentage of good brush was produced in 1918, when the lowest total yield was made, and the lower percentage in 1915, when the highest total yield was made. This tends to show that the percentage of good brush does not depend so much upon the quantity of brush produced as on the conditions under which it is grown. Growth that is too rapid or too slow during the fruiting period has a bad effect on quality. The former makes coarse, burly, or twisted brush and crooked heads, while the latter causes the brush to be short and spiky. The greatest average length of good brush, 21.7 inches, was produced in 1915, and the shortest, 15.5 inches, in 1917. In the former year the length of the poor brush was the same as the good, but the crop made a rapid growth and developed some coarse,

twisted brush. In the latter year growth was retarded, so that a number of short, spiky heads developed which were of poor quality and averaged only 13.2 inches in length. The lowest average percentage of good brush in the 5-year period was made in 1916. In that year the length of good brush averaged 18.8 inches, but it amounted to only 80.9 per cent of the total crop. The same year the average length of the poor brush was only 14.7 inches, or 4 inches less than the good brush. This was due to extremely dry conditions in the latter half of the heading period.

TABLE VII.—*Agronomic data for Dwarf broom corn grown in the varietal experiments at the Woodward (Okla.) Field Station during the 5-year period from 1914 to 1918, inclusive.*

Year and variety.	Row space (inches).		Length of period (days).			Percentage of—		Height of plants (feet).	Yield of brush per acre (pounds).			Length of brush (inches).		Percentage of good brush.
	Plants.	Stalks.	Vegetative.	Fruiting.	Total.	Suckers.	Headed stalks.		Good.	Poor.	Total.	Good.	Poor.	
Season of 1914:														
C. I. No. 442	6.5	**6.5**	73	18	91	0	83.4	3.5	275	20	295	18.0	15.0	93.2
C. I. No. 535	7.5	7.5	73	18	91	0	82.1	3.8	225	20	245	18.0	12.0	91.8
C. I. No. 557	6.5	6.5	73	18	91	0	77.4	4.0	250	100	350	21.0	14.0	71.4
Average of 3	6.8	6.8	73	18	91	0	80.9	3.8	250	47	297	19.0	13.7	85.5
Season of 1915:														
C. I. No. 442	6.3	5.2	81	14	95	17.3	72.7	4.3	511	83	594	21.0	21.0	86.0
C. I. No. 535	6.9	6.0	74	21	95	12.3	96.3	4.8	683	122	805	22.0	22.0	84.8
C. I. No. 557	5.7	5.3	76	19	95	7.0	100.0	5.0	650	205	855	22.0	22.0	76.0
Average of 3	6.3	5.5	77	18	95	12.2	89.7	4.7	615	137	752	21.7	21.7	82.2
Season of 1916:														
C. I. No. 442	9.2	5.3	72	15	87	**41.7**	**75.9**	3.0	283	117	400	17.0	13.5	70.8
C. I. No. 535	9.0	5.9	65	22	87	33.8	81.9	3.8	433	50	483	19.0	14.5	89.7
C. I. No. 557	7.6	6.8	70	17	87	10.7	86.9	3.8	361	78	439	20.5	16.0	82.3
Average of 3	8.6	6.0	69	18	87	28.7	81.6	3.5	359	82	441	18.8	14.7	80.9
Season of 1917:														
C. I. No. 442	7.1	5.9	96	16	112	16.6	94.5	4.0	328	72	400	14.0	12.0	81.9
C. I. No. 535	7.8	7.0	96	18	114	10.0	93.0	5.0	378	72	450	17.0	13.5	84.0
C. I. No. 557	6.8	5.9	109	8	117	12.8	91.2	5.5	378	77	455	15.5	14.0	82.9
Average of 3	7.2	6.3	100	14	114	13.1	92.9	4.8	361	74	435	15.5	13.2	82.9
C. I. No. 559	6.8	6.5	116	17	133	3.0	87.4	4.5	444	45	489	16.5	12.0	90.9
C. I. No. 595	7.5	4.8	107	15	122	35.7	85.3	5.0	365	80	445	16.5	12.5	82.0
C. I. No. 597	7.6	6.8	107	15	122	10.7	95.5	5.5	411	50	461	17.0	14.0	89.2
Average of 3	7.3	6.0	110	16	126	16.5	89.4	5.0	407	58	465	16.7	12.8	87.4
Average of 6	7.3	6.2	105	15	120	14.6	91.1	4.9	384	66	450	16.1	13.0	85.1
Season of 1918:														
C. I. No. 442	7.6	5.3	66	19	85	30.1	59.3	2.3	188	37	225	14.0	13.5	83.3
C. I. No. 535	6.9	5.6	67	17	84	18.7	57.3	3.5	239	50	289	19.5	14.0	82.7
C. I. No. 557	7.2	5.6	69	15	84	21.4	70.4	3.5	294	28	322	16.5	13.5	91.4
Average of 3	7.2	5.5	67	17	84	23.4	62.3	3.1	240	38	278	16.7	13.7	85.8
C. I. No. 559	6.3	5.7	86	22	108	10.6	15.2	4.3	75	10	85	16.5	13.0	87.1
C. I. No. 564	7.8	6.5	70	25	95	16.7	58.2	4.0	178	22	200	16.5	12.5	88.9
C. I. No. 595	7.7	5.0	67	19	86	35.1	56.9	3.5	278	44	322	19.5	15.0	86.2
C. I. No. 597	8.0	5.6	70	16	86	29.9	58.7	3.5	294	25	319	18.5	15.5	92.2
Average of 4	7.5	5.7	73	21	94	23.1	47.3	3.8	206	25	231	17.8	14.0	88.6
Average of 7	7.3	5.6	70	19	89	23.2	53.5	3.5	221	31	252	17.3	13.9	87.4

COMPARATIVE YIELDS IN THE VARIETAL EXPERIMENTS.

The annual and average acre yields of brush of good and of poor quality from all the selections in all three groups of broom corn grown in the varietal experiments are shown in Table VIII. The

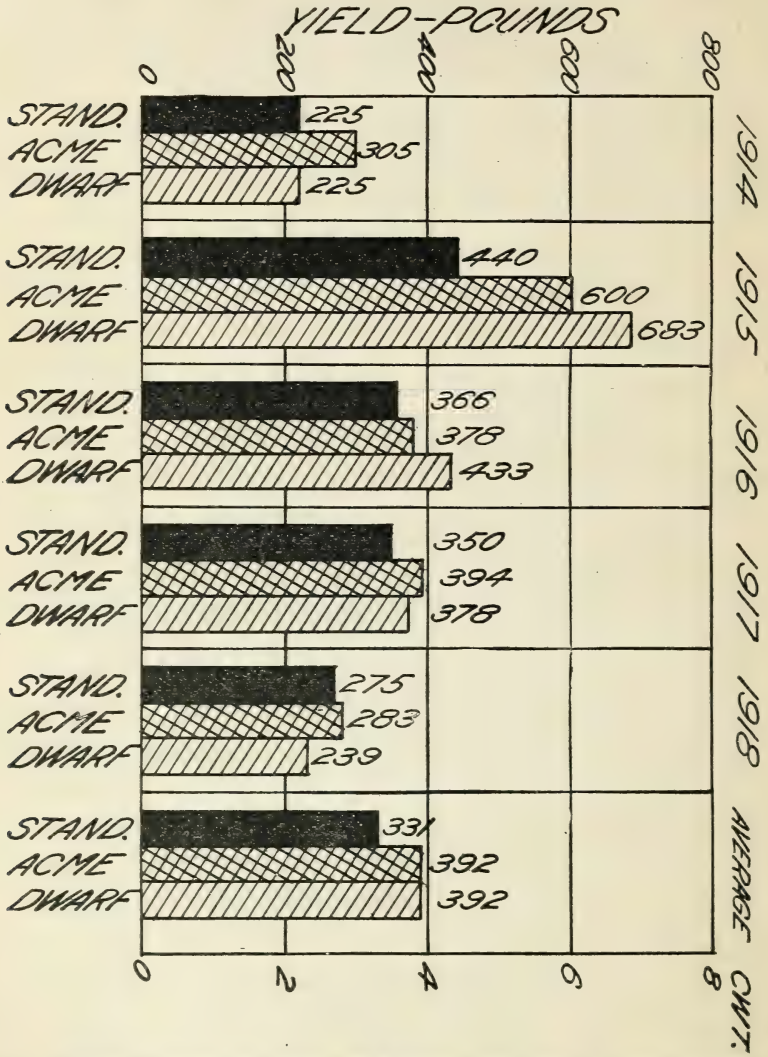

FIG. 6.—Diagram showing the annual and average acre yields of good brush of the Standard, Acme, and Dwarf broom corn grown in varietal experiments at the Woodward Field Station during the 5-year period from 1914 to 1918, inclusive.

average yields are given first for the two years, 1917 and 1918, in order to compare a few selections grown only in those years. The average yields in the full 5-year period from 1914 to 1918, inclusive, are given for all selections grown for that length of time.

Table VIII shows that a selection of Dwarf broom corn (C. I. No. 597) made the highest average yield of good brush in the 2-year period, with the Acme variety taking second place, while several other Dwarf selections are close competitors for third place. In the 5-year period, the Acme and the Dwarf (C. I. No. 535) tie for first place, with an average yield of 392 pounds of good brush. The

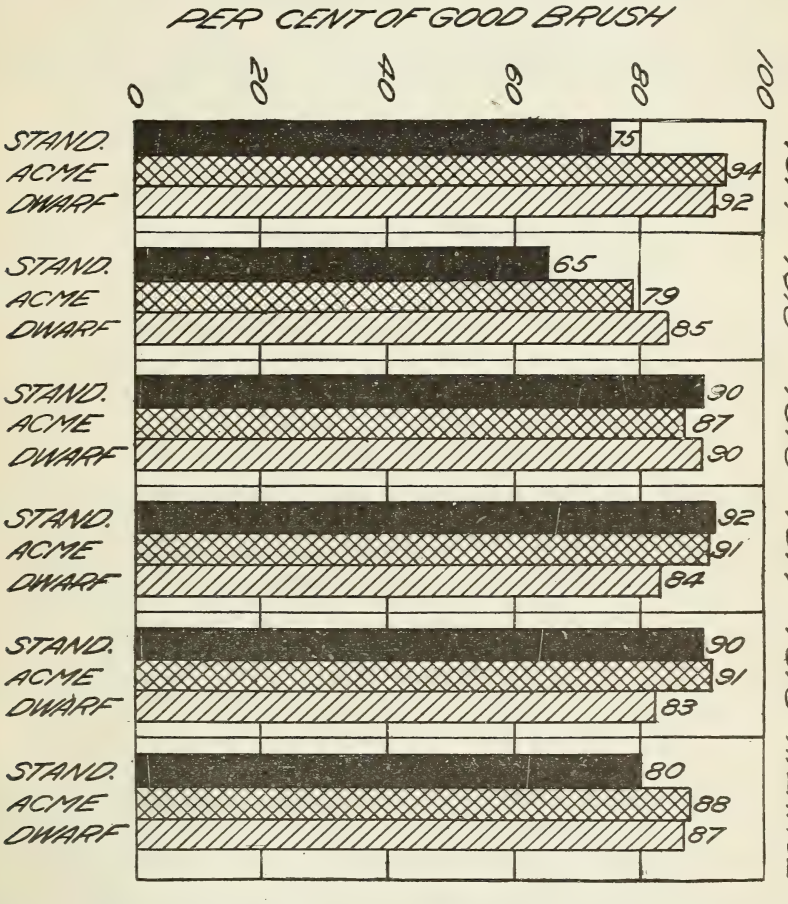

FIG. 7.—Diagram showing the annual and average percentage of good brush in the total yield produced by the Standard, Acme, and Dwarf broom corn grown in varietal experiments at the Woodward Field Station during the 5-year period from 1914 to 1918, inclusive.

Dwarf (C. I. No. 557), with an average yield of 387 pounds, or only 5 pounds less, takes a close second place, and the Standard (C. I. No. 556) takes third place, with an average yield of 331 pounds in this period. The 5-year average yield of the Standard, Acme, and Dwarf varieties is shown graphically in figure 6.

From the standpoint of the percentage of good brush in the total yield produced in the 5-year period from 1914 to 1918, inclusive, the

Acme stands first, with an average of 88 per cent, while the Dwarf (C. I. No. 535), is a close second, with an average of 87 per cent. This selection leads the next highest selection, Dwarf (C. I. No. 442), by 4 per cent, while the other two varieties, one Standard and the other Dwarf, grown in that period, tie for fourth place, with 80 per cent each. The percentage of good brush produced by the Standard, Acme, and Dwarf varieties is shown graphically in figure 7.

TABLE VIII.—*Annual and average acre yields of all lots of broom corn grown in varietal experiments at the Woodward (Okla.) Field Station during periods of varying length in the five years from 1914 to 1918, inclusive.*

Variety.	Annual acre yields (pounds).										Average yields.			
	1914		1915		1916		1917		1918		2 years, 1917 and 1918.		5 years, 1914 to 1918.	
	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.
Standard:														
C. I. No. 556	225	75	440	235	366	39	350	31	275	30	312	30	331	82
C. I. No. 580	.....	.....	.....	.....	.....	.....	160	45	356	22	258	33	.....	.....
C. I. No. 588	.....	.....	.....	.....	.....	.....	200	33	.....	.....	.....	.....	.....	.....
Acme:														
C. I. No. 243	305	20	600	155	378	55	394	39	283	28	338	33	392	59
Dwarf:														
C. I. No. 442	275	20	511	83	283	117	328	72	188	37	258	54	317	66
C. I. No. 535	225	20	683	122	433	50	378	72	239	50	308	61	392	63
C. I. No. 557	250	100	650	205	361	78	378	77	294	28	336	52	387	98
C. I. No. 559	.....	.....	.....	.....	.....	.....	444	45	75	10	259	27	.....	.....
C. I. No. 564	.....	.....	.....	.....	.....	.....	.....	.....	178	22	.....	.....	.....	.....
C. I. No. 595	.....	.....	.....	.....	.....	.....	365	80	278	44	321	62	.....	.....
C. I. No. 597	.....	.....	.....	.....	.....	.....	411	50	294	25	352	37	.....	.....

DATE-OF-SEEDING EXPERIMENTS.

A date-of-seeding experiment with Acme broom corn was conducted each year during the 5-year period from 1914 to 1918, inclusive. The plats used in this experiment were one-tenth acre in size. Seeding was done at intervals of one to two weeks. In 1914 the experiment included only three different dates. These were increased to four dates in 1915, to six dates in 1916, and to seven dates each in 1917 and 1918.

Table IX shows the agronomic data for Acme broom corn in the date-of-seeding experiment. It will be noted in this table that the stands obtained in the different dates of seeding in the same year and in the different years are comparable in almost all cases except those of the last date, July 3, 1917, and the first three dates in 1918. The thin stand in the former case was due to the dry condition of the soil and to high temperature at and following the date of seed-

ing. Germination was low, and a number of the young plants did not have vigor enough to withstand the heat after they emerged. In 1918 the thin stands were due to the poor quality of the seed used. This seed was slightly frosted before harvest the previous year. Though it showed a fairly high germination in laboratory tests made prior to seeding time, it evidently was losing its vitality will age, as the stand of each successive seeding was thinner than that of the preceding one. For the last three dates in 1918, seed from another source was used, which gave a stand comparable with the stands in the other years.

The shortest total growing period required by the crop from any one date of seeding was 73 days, which resulted from the seeding made on April 16, 1917. In any one of the first three years, 1914, 1915, and 1916, the variation in the duration of the total growing periods of plats sown at different dates amounted to about 15 days. In the 3-year period the greatest variation amounted to 24 days. In 1917 the time required for the crop to mature was much longer than it was in any other year. In that year the shortest time was 100 days from the June 2 seeding and the longest time 137 days from the April 16 seeding. The abnormally long time required by the crop was due to the very unfavorable growing conditions which obtained in varying degrees through the months of May, June, July, and September. The moisture in August was enough to promote normal plant growth. The unusually short time required to reach maturity by the crop sown on July 1, 1916, was due to the lack of moisture at and following the time the crop was heading. Only 79.3 per cent of the total number of stalks in the crop produced heads.

Suckering is influenced largely by growing conditions and varies widely in the same variety when grown under different conditions. In 1914 the suckers amounted to less than 1 per cent of the total number of stalks resulting from any one of the dates of seeding, while in 1915 they ranged from 4.8 per cent to 28.1 per cent of the total. The percentage in 1916 varied about the same as it did in 1915, but it shows quite an increase in 1917, reaching 40 per cent in the July 3 seeding. However, a still wider variation occurred in 1918, when the highest was 62.8 per cent and the lowest only 6.5 per cent. This is a difference of 56.3 per cent, which was due to differences in stand and other environing conditions.

The percentage of stalks that head is influenced largely by growing conditions at heading time. When there is sufficient moisture to develop normal plant growth throughout that stage the percentage of heads developed to total stalks will be much larger than will be the case otherwise. There may be as wide a variation in the percentage of heads developed in plants sown at different dates

in the same year as in plats sown on the same date in the different years. The lowest, 60.7 per cent, in the 5-year period was from the seeding made June 1, 1918, and the highest, 97.5 per cent, was from the seeding made on May 24, 1917. In the former case it will be noted in Table II, which shows the daily and monthly precipitation, that the crop was grown under very dry conditions. In the latter, the month of August, at which time the crop was heading, was quite favorable.

The average height of the plants in the different years ranges from 3.5 to 6.3 feet. The height depends largely upon the rapidity of growth during the first 30 or 40 days of the vegetative period. When the height of 6.3 feet resulted from the seeding made June 19, 1915, the soil was in a moist condition and remained so for some time, with a temperature favorable for rapid growth. At other times during several of the years when the plants reached a height of less than 4 feet, the crop encountered a long droughty spell during the vegetative period.

TABLE IX.—*Agronomic data for Acme broom corn in the date-of-seeding experiments at the Woodward (Okla.) Field Station during the 5-year period from 1914 to 1918, inclusive.*

Date of seeding.	Row space (inches).		Length of period (days).			Percentage of—		Height of plants (feet).	Yield of brush per acre (pounds).			Length of brush (inches).		Percentage of good brush.
	Plants.	Stalks.	Vegetative.	Fruiting.	Total.	Suckers.	Headed stalks.		Good.	Poor.	Total.	Good.	Poor.	
Season of 1914:														
May 14	5.8	5.8	73	17	90	0	81.8	4.0	305	60	365	21.0	15.0	80.8
June 1	4.4	4.4	69	22	91	0	68.0	4.3	.....	.....	a612	.....	.....	.....
June 18	5.7	5.7	64	10	74	0	77.9	4.3	.....	.....	a780	.....	.....	.....
Season of 1915:														
May 25	5.5	5.2	77	18	95	4.8	93.0	5.5	600	155	755	23.0	23.0	79.4
June 10	8.6	6.2	78	19	97	28.1	86.7	5.8	750	45	795	22.0	22.0	93.3
June 19	5.6	4.4	80	18	98	20.4	88.2	6.3	875	20	895	20.0	20.0	97.8
July 7	5.9	4.9	69	14	83	15.8	79.2	.....	630	70	700	19.0	19.0	90.0
Season of 1916:														
May 1	5.8	5.5	70	18	88	5.2	89.0	4.8	717	25	742	23.0	14.0	96.6
May 15	6.0	5.2	72	14	86	13.0	70.0	4.5	556	7	563	23.0	19.0	98.9
May 22	8.7	6.6	70	17	87	24.1	83.6	3.8	378	55	433	18.5	16.0	87.2
June 1	5.8	5.5	64	19	83	5.2	83.0	4.0	328	22	350	20.0	13.5	93.7
June 15	5.9	5.1	53	24	77	13.8	91.3	3.8	475	68	543	22.5	18.0	87.4
July 1	5.9	5.4	51	22	73	9.7	79.3	3.8	457	57	514	22.0	19.0	88.9
Season of 1917:														
April 16	6.3	4.9	124	13	137	21.5	83.3	4.0	275	68	343	12.5	11.0	80.0
May 2	6.0	4.6	110	11	121	24.7	86.0	5.0	350	106	456	14.0	12.0	76.7
May 15	5.9	4.9	106	12	118	16.8	90.8	5.0	450	81	531	14.0	12.0	84.7
May 24	7.1	6.5	107	8	115	8.7	97.5	5.5	394	39	433	17.0	13.0	91.0
June 2	6.7	5.9	92	8	100	11.9	92.6	5.5	507	36	543	18.0	15.0	93.4
June 22	7.4	6.1	95	14	109	17.6	83.1	4.5	625	44	669	19.0	15.0	93.5
July 3	10.5	6.1	88	17	105	41.0	75.6	5.0	633	50	683	20.0	14.0	92.7
Season of 1918:														
April 16	27.6	10.3	92	16	108	62.7	91.3	3.8	286	57	343	22.5	18.5	83.3
May 1	22.6	10.2	84	11	95	55.1	80.0	3.5	193	50	243	19.0	16.0	79.4
May 14	39.4	14.6	83	15	98	62.8	90.5	4.5	214	14	228	22.5	15.5	93.8
May 27	7.5	5.8	69	15	84	22.6	66.6	3.5	283	28	311	17.5	15.5	91.1
June 1	7.0	6.6	76	14	90	6.5	60.7	3.5	238	12	250	18.0	12.5	95.0
June 15	5.8	5.4	75	18	93	7.2	84.4	3.5	129	142	271	14.5	11.0	47.4
July 1	8.9	8.3	94	39	133	7.3	76.7	3.8	260	90	350	17.0	11.5	74.3

a Weight of seeded brush before curing.

The yield of good brush, the total yield, the length of the brush, and the percentage of good brush in the total yield vary widely between the different dates of seeding in nearly all years. Good to excellent yields were obtained from one or more of the seedings each year, while those from other seedings were only fair to poor. In 1914 the yield of the cured brush was obtained on one lot only. The other two lots were weighed green after thrashing and accidentally placed on the racks to cure without being properly labeled, which made later identification impossible. The season of 1915 was exceptionally favorable throughout, which resulted in excellent yields from all the dates of seeding. The lowest yield in that year was 700 pounds from the seeding made July 7 and the highest 895 pounds from the seeding of June 19. In the variable season of 1916 the yields ranged from 742 pounds from the May 1 seeding to only 350 pounds from the seeding made on June 1. In 1917 the highest yield was obtained from the seeding made on July 1, the next highest from the June 22 seeding, and the lowest yield from the early seeding, April 16. In 1918, the poorest crop season in the 5-year period, the highest yield, 350 pounds, was from the seeding made July 1, while the lowest, 250 pounds, was made from the June 1 seeding.

COMPARATIVE YIELDS IN THE DATE-OF-SEEDING EXPERIMENTS.

Table X shows the annual and average acre yields of Acme broom corn in the date-of-seeding experiments. The seedings in the different years in some cases were not made on exactly the same date. These dates in some cases varied as much as five days. The resulting yields are considered comparable and in this table are grouped accordingly. Therefore, seedings made on May 22 and 27, on June 10 and 15, and on June 18 and 22 in different years are considered as representing the same dates of seeding.

The annual yields of the good and the poor qualities are shown first. Then is given a 2-year average yield from the plats on all dates used in that period, and then a 3-year average yield for the comparable dates in that period. It will be noted here that the lowest average yield in the 2-year period was from the seedings made on May 1 and that the average yields increased as the date of seeding advanced, reaching the maximum of 446 pounds of good brush from the July 1 seedings. In the 3-year period from 1916 to 1918, inclusive, the highest average yield of good brush, 450 pounds, was obtained from the July 1 seeding, while the second highest, 420 pounds, was from the seedings made on May 1.

These results indicate that the best times to sow are from about May 1 to 15 and from June 15 to July 1. August is usually dry and hot, and such weather has a bad effect on yield and quality of

brush if the crop is in the heading stage at that time. This may be avoided by seeding either early or late.

TABLE X.—*Annual and average acre yields of Acme broom corn in date-of-seeding experiments at the Woodward (Okla.) Field Station in the 5-year period from 1914 to 1918, inclusive.*

Date of seeding.	Annual acre yields (pounds).										Average yields.			
	1914		1915		1916		1917		1918		2 years, 1917 and 1918.		3 years, 1916 to 1918.	
	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.
April 16	.....	.....	.....	.....	.....	.....	275	68	286	57	280	62	.....	.....
May 1 and 2	.....	.....	.....	.....	717	25	350	106	193	50	272	78	420	60
May 14 and 15	305	60	.....	.....	556	7	450	81	214	14	332	47	407	34
May 22 to 27	.....	.....	600	155	378	55	394	39	283	28	339	33	352	41
June 1 and 2	.....	.....	.....	.....	328	22	507	36	238	12	372	24	358	23
June 10 to 15	.....	.....	750	45	475	68	.....	.....	129	142	.....	.....	.....	.....
June 18 to 22	.....	.....	875	20	378	55	625	44	.....	.....	.....	.....	.....	.....
July 1 to 7	.....	.....	630	70	457	57	633	50	260	90	446	70	450	66

RATE-OF-SEEDING EXPERIMENTS.

The rate-of-seeding experiments were conducted with Standard broom corn, C. I. No. 556, and Dwarf broom corn, C. I. No. 557, in the 5-year period from 1914 to 1918, inclusive. Both varieties were sown in each year at three rates, designated as thick, normal, and thin. These rates represent stands of approximately one plant to 4 inches of row space in the thick rates, to 7 inches in the normal rate, and to 10 inches in the thin rate. All rows were spaced 3.5 feet apart. The combined rate-of-seeding and spacing experiments with Acme broom corn, C. I. No. 243, have these same rates included. A discussion of these experiments follows later.

The agronomic data from the rate-of-seeding experiments are shown in Tables XI and XII. It will be seen in Table XI that the stand in each rate of seeding is not exactly the same for both varieties the same year; neither is it the same for each rate in the different years. But the difference in the stands of the varieties in the same rates in any one year is so small that its influence on yields is considered negligible.

The total growing period for the Standard broom corn in the different years ranged from 94 days in 1914, the shortest time required, to 132 days in 1917, the longest. For the Dwarf variety in these same years the time was 91 days and 117 days, respectively, which is 3 days less in the first year mentioned and 15 days less in the second. In each of the other three years the Standard required from 6 to 11 days longer to mature than the Dwarf.

In 1914 neither variety produced suckers. In 1915 none were produced in the thick or the normal rates of the Standard broom

corn, but the thin rate produced 9.3 per cent, while in the Dwarf that year the proportion varied from 3.4 per cent in the thick to 26.3 per cent in the thin rate. In 1916 suckers were produced in all rates in both varieties, though the number in the Standard was much smaller than in the Dwarf variety. In 1917 the Standard broom corn produced suckers in all three rates, but in the Dwarf they were present only in the normal and the thin rates. In 1918 there were no suckers in the Standard broom corn sown at the thick rate, but they were present in all three rates in the Dwarf variety. The tendency to sucker is present in both varieties, though to a larger degree in the Dwarf than in the Standard. The development of this tendency is influenced largely by environing condition. Stand is an important factor. Thin stands aid the development of suckers, while thick stands suppress them.

The percentage of stalks headed varies in the plats sown at the different rates in the same year and in the same rates in the different years. This is due in part to seasonal conditions and in part to the number of suckers produced. In the years when suckering was reduced to the minimum, the percentage of headed stalks usually increased as the stand decreased. The reverse is true when the plants sucker profusely. This is so especially when the suckers are late and none of them produce heads. The rates of seeding used in this experiment appear to have had no appreciable effect on the height of the plants.

The highest 5-year yields of good brush of the Standard variety were made in two years at the thick rate of seeding and in two years at the thin rate. The highest total yields of this variety were produced in two years at the thick rate and in three years at the normal rate of seeding. The Dwarf variety made the highest yields of good brush at the thick rate during three years, and in one year each at the normal and thin rates. In total brush produced, the thick rate led in two years and the other two rates each led in one year and tied in another year.

The yield can not be considered the only factor in determining the proper rate of seeding. The length of the brush to be produced is also an important factor. Thick stands tend to produce short brush and thin stands long brush. The fiber may be of good quality but too short to be self-working, or it may be too long to be worked to good advantage without waste in making brooms of average length. Hurl brush that ranges from 18 to 22 inches works to best advantage in the manufacture of parlor and house brooms. Longer brush is required for heavy warehouse and street brooms. Short brush, ranging in length from 12 to 16 inches, is used for insides and for covers to some extent.

The length of the brush varies in most cases with the different rates of seeding in the same year, and it varies according to seasonal conditions with the same rate of seeding in the different years. In the Standard broom corn, the average length of the brush seeded at the thick rate ranged from 15.5 inches in 1918 to 21 inches in 1914, with an average length of 17.9 inches in the 5-year period. The length of the brush from the normal rate ranges from 18.5 inches in 1917 and 1918 to 22 inches in each of the other three years, with an average length of 20.6 inches in the whole period. From the thin rate of seeding the brush length ranges from 18.5 inches in 1918 to 25 inches in 1915 and average 21.5 inches in the entire period.

The length of the brush in the Dwarf variety was influenced by the stand, as it was in the Standard broom corn, but not always to the same extent in the same year. The shortest length produced by this variety from the thick rate was 16.5 inches in 1917 and the longest 21 inches in 1914, with an average of 18.5 inches for the 5-year period. The length of brush seeded at the normal rate ranged from 15.5 inches in 1918 to 22 inches in 1915, with an average of 19.1 inches. From the thin rate the brush length ranged from 17.5 inches in 1917 to 24 inches in 1914 and averaged 19.7 inches for the whole period.

The percentage of good brush in the total brush produced varies with the stand and seasonal conditions. The good brush produced by the Standard variety at the thick rate of seeding ranged from 64.2 per cent of the total in 1914 to 89.4 per cent in 1917, with an average of 77.5 per cent in the 5-year period. The production of good brush from seed sown at the normal rate ranged from 65.2 per cent in 1915 to 91.8 per cent in 1917, and averaged 82.5 per cent in the entire period. At the thin rate the lowest production was 42.7 per cent in 1915 and the highest 89.7 per cent in 1918, with an average of 76.5 per cent.

The Dwarf broom corn produced 68.4 per cent of good brush out of the total yield from the thick rate of seeding in 1914 and 84.6 per cent in 1916, with an average of 79.7 per cent in the 5-year period. From the normal rate of seeding, the lowest proportion, 76 per cent, was produced in 1915, and the highest, 91.4 per cent, in 1918, with an average of 80.8 per cent in the entire period. The lowest proportion of good brush from seed sown at the thin rate was 75.3 per cent in 1917, and the highest was 93.3 per cent in 1918, with an average of 84.7 per cent in the whole period.

From the foregoing data it will be seen that no one rate led in the percentage of good brush produced in all years. The average yield of good brush from different rates of seeding during the whole period indicates which is the most profitable rate of seeding. In the Standard broom corn, the highest average percentage of good brush in the

5-year period was 82.5 per cent, which was produced from the normal rate. In the Dwarf variety, the average production of good brush increased from 79.7 per cent at the thick rate to 84.7 per cent at the thin rate. The average from the normal rate was 80.8 per cent.

TABLE XI.—*Agronomic data for Standard broom corn, C. I. No. 556, and Dwarf broom corn, C. I. No. 557, in rate-of-seeding experiments at the Woodward (Okla.) Field Station during the 5-year period from 1914 to 1918, inclusive.*

Year, variety, and rate.	Row space (inches).		Length of period (days).			Pecentage of—		Height of plants (feet).	Yield of brush per acre (pounds).			Length of brush (inches).		Percentage of good brush.
	Plants.	Stalks.	Vegetative.	Fruiting.	Total.	Suckers.	Headed stalks.		Good.	Poor.	Total.	Good.	Poor.	
1914, Standard:														
Thick	4.7	4.7	77	17	94	0	65.8	7.0	150	90	240	18.0	13.0	64.2
Normal	6.7	6.7	77	17	94	0	79.6	6.5	225	75	300	22.0	14.0	75.0
Thin	10.7	10.7	77	17	94	0	81.1	7.0	212	69	281	24.0	18.0	75.6
1914, Dwarf:														
Thick	5.1	5.1	73	18	91	0	68.7	4.0	130	60	190	21.0	15.0	68.4
Normal	6.5	6.5	73	18	91	0	77.4	4.0	250	100	350	21.0	14.0	71.4
Thin	8.1	8.1	73	18	91	0	76.1	4.0	300	50	350	24.0	15.0	85.7
1915, Standard:														
Thick	4.2	4.2	80	21	101	0	84.8	8.3	538	118	656	20.0	20.0	81.9
Normal	5.8	5.8	80	21	101	0	94.4	8.3	440	235	675	22.0	22.0	65.2
Thin	9.4	8.6	80	21	101	9.3	78.0	8.3	295	220	515	25.0	25.0	42.7
1915, Dwarf:														
Thick	4.1	3.9	76	19	95	3.4	95.4	5.8	667	133	800	20.0	20.0	83.3
Normal	5.7	5.3	76	19	95	7.0	100.0	5.0	650	205	855	22.0	22.0	76.0
Thin	8.1	6.0	76	19	95	26.3	87.2	5.0	594	150	744	22.0	22.0	79.9
1916, Standard:														
Thick	4.7	4.6	73	18	91	1.1	82.5	6.8	372	78	450	18.0	14.0	82.7
Normal	8.0	7.5	73	18	91	6.6	86.1	7.0	367	38	405	22.0	15.0	90.4
Thin	9.3	8.5	72	19	91	8.4	90.3	6.8	385	40	425	20.0	15.0	90.6
1916, Dwarf:														
Thick	4.7	4.5	70	17	87	2.8	85.4	4.0	440	80	520	18.0	14.0	84.6
Normal	7.6	6.8	70	17	87	10.7	86.9	3.8	361	78	439	20.5	16.0	82.3
Thin	10.0	6.6	70	17	87	34.5	79.9	4.0	420	50	470	19.0	14.5	89.4
1917, Standard:														
Thick	5.1	4.9	112	20	132	3.3	84.3	7.0	380	45	425	18.0	16.5	89.4
Normal	7.0	6.5	112	20	132	6.1	80.8	7.0	350	31	381	18.5	16.5	91.8
Thin	9.8	8.4	108	24	132	14.6	75.3	7.0	260	50	310	20.0	17.5	83.9
1917, Dwarf:														
Thick	4.8	4.8	109	8	117	0	93.5	5.8	390	100	490	16.5	14.0	79.6
Normal	6.8	5.9	109	8	117	12.8	91.3	5.5	378	77	455	15.5	14.0	82.9
Thin	9.5	8.0	109	8	117	15.3	93.2	5.5	305	100	405	16.0	14.0	75.3
1918, Standard:														
Thick	4.0	4.0	78	17	95	0	51.0	5.8	125	55	180	15.5	12.5	69.4
Normal	8.6	6.9	78	17	95	20.3	73.3	6.0	275	30	305	18.5	13.5	90.1
Thin	11.1	7.7	78	17	95	30.4	71.3	6.0	260	30	290	18.5	13.5	89.7
1918, Dwarf:														
Thick	4.5	4.3	69	15	84	5.8	53.2	3.5	215	45	260	17.0	14.0	82.7
Normal	7.2	5.6	69	15	84	21.4	70.4	3.5	294	28	322	16.5	13.5	91.4
Thin	10.8	5.7	69	15	84	47.2	57.8	3.5	280	20	300	17.5	13.5	93.3

COMPARATIVE YIELDS IN THE RATE-OF-SEEDING EXPERIMENTS.

The yield and the quality of the brush are influenced by seasonal conditions. No one rate of seeding, therefore, will prove best in all years. But as the season can not be foretold the rate that gives the highest average yield in a series of years would appear to be the most profitable. Table XII shows the annual and the average acre yields of both good and poor brush by both the Standard and Dwarf

broom corn in the 5-year period from 1914 to 1918, inclusive. It may be noted in this table that the highest yield of good brush from the Standard variety in any year was 538 pounds, produced by seeding at the thick rate in 1915, and the lowest yield was 125 pounds, from seed sown at the same rate in 1918. The annual yield from the normal rate of seeding in the five years exceeded that of the other rates in two years only, but the 5-year average yield of this rate is 331 pounds. This is 18 pounds more than the average yield at the thick rate and 49 pounds more than the average yield from the thin rate in the 5-year period. The normal rate of seeding, or a stand of one plant to 6 or 8 inches of row space, appears to be the most profitable rate for a series of years.

From the Dwarf variety the highest annual yield of good brush in the 5-year period was 667 pounds, which was produced by seed sown at the thick rate of 1915. The lowest yield, 130 pounds, was produced at this same rate of seeding in 1914. The normal rate produced a higher yield than either the thick or thin rates in only one year in the 5-year period. However, the normal rate produced a fair yield each year and averaged 387 pounds in the 5-year period. This is 19 pounds more than the average of the seeding at the thick rate and 7 pounds more than the average yield at the thin rate in the 5-year period. From these results it will be seen that in a series of years, including both favorable and unfavorable seasons, the normal rate or a stand providing 6 to 8 inches of row space to the plant is the most profitable rate of seeding and the one that should be used for this variety under similar conditions.

TABLE XII.—*Annual and average acre yields of Standard and Dwarf broom corn in rate-of-seeding experiments at the Woodward (Okla.) Field Station during the 5-year period from 1914 to 1918, inclusive.*

Variety and rate.	Annual acre yields (in pounds).										Average yields for the 5 years, 1914 to 1918.	
	1914		1915		1916		1917		1918			
	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.
Standard:												
Thick	150	90	538	118	372	78	380	45	125	55	313	77
Normal	225	75	440	235	367	38	350	31	275	30	331	82
Thin	212	69	295	220	385	40	260	50	260	30	282	82
Dwarf:												
Thick	130	60	667	133	440	80	390	100	215	45	368	84
Normal	250	100	650	205	361	78	378	77	294	28	387	98
Thin	300	50	594	150	420	50	305	100	280	20	380	74

COMBINED RATE-OF-SEEDING AND SPACING EXPERIMENTS.

The combined rate-of-seeding and spacing experiments were conducted with Acme broom corn and consist of different rates of seed-

ing, different numbers of plants in the hills, and different spacing of the rows, either 3.5 or 7 feet apart. The object of these experiments was to determine the reaction of the crop to these different environing conditions. The first section of these experiments consisted of six plats each year during the 5-year period from 1914 to 1918, inclusive, except in 1916, when there were five plats only. The rows in these plats were spaced 3.5 feet apart, with only one plant in each hill, but with the hills spaced at different distances. Each plat each year, therefore, represented a different rate of seeding.

The second section of these experiments consisted of the same number of plats at the same rates each year with the rows spaced the same distance apart (3.5 feet) as in the first part, but each hill contained two plants instead of one. These hills occupied twice as much row space per hill as those in the corresponding rate in the first section of the experiments, so that the space per plant was the same for each plat as for the corresponding plat in the first section.

The third section of these experiments differs from the first and second sections in its duration, in the number of rates of seeding and the spacing represented, and in the grouping of the plants in the hills. The experiments were conducted only during the last three years, 1916 to 1918, inclusive. The plants are grouped four in each hill. The two rates of seeding or of spacing hills employed correspond to two of the rates previously described.

The fourth and last section of these experiments contains the same number of plats sown at the same rates each year as were included in either the first or second section. It differs from them in the spacing of the rows, which are 7 feet apart, and in the hills, which contain one plant only but are twice as thick in the row as in either of the other plats sown at the same rate but with the rows spaced 3.5 feet apart.

ONE PLANT PER HILL, ROWS 3.5 FEET APART.

Table XIII shows the agronomic data obtained from the first section of the rate-of-seeding and spacing experiments. It will be noted in this table that in 1914 the stand varied from 2.8 inches of row space per hill or plant at the thickest rate to 10.5 inches at the thinnest rate. The thickest rate in 1915 was one plant to 3.6 inches of row space and the thinnest rate one plant to 13.5 inches of row space. In 1916 there were five rates only. The thickest rate that year was one plant to 4.5 inches of row space and the thinnest rate 18.1 inches of row space to the plant. Six rates of seeding were used in 1917. The thickest stand in that year was 3 inches of row space to the hill and the thinnest 19.3 inches of row space, with four rates between

these extremes. In 1918 the stands from all six rates were identical with those of the previous year.

The rate at which the crop was sown appears to have had no influence on either the vegetative or fruiting periods under normal or favorable growing conditions, such as obtained in the years 1914 and 1915. In these years both periods were the same for all the rates. In the less favorable seasons of 1916, 1917, and 1918 some differences are shown in the length of both the vegetative and fruiting periods. But these differences are not altogether consistent with the rates of seeding. In some cases the plants sown at the thick rates required a longer time in the vegetative period than those at the thinner rates, but in others the reverse is true. This may be due in part to the larger percentage of suckers produced at thin rates. The suckers are later than the main stalks, and if they produce heads, which is not unusual, both the vegetative and fruiting periods may be prolonged.

In 1914 no suckers were produced. In the other years their production at the different rates of seeding increased as the stands decreased, though the percentage in the same rates differed in these years. It was usually highest in the years with seasons most favorable to suckers.

There is no apparent correlation between the percentage of headed stalks and the stand. The percentage of stalks headed varies at the different rates in the same year and at the same rates in the different years, but the variations are not consistent with the rates in either case.

In 1914 the average height of the stalks ranged from 4.3 feet in two of the thicker rates to only 4 feet in the thinner rates. In 1915 the average height, 5.8 feet, was the same in all rates. In 1916 the height of the plants in the thickest and thinnest rates averaged 4 feet only, while the average for two of the intermediate rates was 4.5 feet and 4.3 feet for another rate. In 1917 the stalks averaged highest in the thicker rates and lowest in the intermediate rates, with a noticeable increase in height again in the thinnest rate. The lowest average height, 3.3 feet, in 1918, was in the thickest rate, and the highest average, 4 feet, was in the fifth rate, with a slight decline in the thinnest rate. It appears that the effect of the rate of seeding on the height of the stalks is dependent upon seasonal conditions. When the moisture is sufficient to promote normal growth in the early part of the vegetative period the thick rates produce the taller stalks, and the reverse is true when there is a lack of moisture at that stage of growth.

The yield per acre is shown in pounds: (1) That of good brush, (2) that of poor brush, and (3) the total yield of all brush, which is the combined yields of the good and poor qualities. The yields

from sowings at different rates in the same year and from the same rates in different years are not alike, owing primarily to seasonal conditions. It is interesting to note, however, that the highest yield was produced by seedings at the intermediate rates in three years of the 5-year period. The thickest rate outyielded all others in 1917, when there was 7 inches of rainfall in August, and the thinnest rate ranked first in 1918, when the rainfall in August amounted to 0.7 of an inch only. These are the extreme rates of seeding and they can give best results only under extreme seasonal conditions.

The stand has an influence on the length of the brush. Thick stands tend to produce short brush, and thin stands long brush. The difference between the length of the brush produced by the thickest and the thinnest stands in the 5-year period ranges from 6 inches in 1914 to 2 inches in each of the years 1915 and 1917. In 1916 it was 3 inches, and in 1918 there was a difference of 5 inches.

TABLE XIII.—*Agronomic data for Acme broom corn in the combined rate-of-seeding and spacing experiments at the Woodward (Okla.) Field Station during the 5-year period from 1914 to 1918, inclusive.*

[One plant in each hill; rows spaced 3.5 feet apart.]

Year.	Row space (inches).		Length of period (days).			Percentage of—		Height of plants (feet).	Yield of brush per acre (pounds).			Length of brush (inches).		Percentage of good brush.
	Hills.	Stalks.	Vegetative.	Fruiting.	Total.	Suckers.	Headed stalks.		Good.	Poor.	Total.	Good.	Poor.	
1914	2.8	2.8	73	17	90	0	62.5	4.3	140	100	240	18.0	13.0	58.3
	4.3	4.3	73	17	90	0	66.7	4.3	215	90	305	19.0	15.0	70.5
	5.8	5.8	73	17	90	0	81.8	4.0	305	60	365	21.0	15.0	80.8
	7.7	7.7	73	17	90	0	87.4	4.0	305	20	325	22.0	14.0	93.8
	10.3	10.3	73	17	90	0	67.6	4.0	250	20	270	24.0	17.0	92.6
	10.5	10.5	73	17	90	0	84.2	4.0	280	10	290	24.0	15.0	96.6
1915	3.6	3.6	75	16	91	0	81.4	5.8	683	89	772	22.0	20.0	88.5
	4.8	4.6	75	16	91	4.0	86.9	5.8	775	87	862	23.0	21.0	89.9
	6.3	5.7	75	16	91	8.7	86.1	5.8	685	110	795	23.0	21.0	86.2
	9.4	7.2	75	16	91	24.0	85.5	5.8	590	75	665	25.0	23.0	88.8
	10.9	5.6	75	16	91	48.6	89.2	5.8	735	70	805	23.0	21.0	91.3
	13.5	6.2	75	16	91	54.1	88.4	5.8	650	80	730	24.0	22.0	89.0
1916	4.5	4.3	74	13	87	2.7	79.0	4.0	405	65	470	20.0	15.5	86.2
	6.5	6.0	73	14	87	7.5	90.9	4.5	531	44	575	22.5	18.5	92.4
	9.1	7.4	71	14	85	19.3	90.5	4.5	480	75	555	23.5	18.0	86.5
	12.3	7.8	71	14	85	36.9	89.1	4.3	415	90	505	20.0	16.5	82.2
	18.1	9.3	71	12	83	48.4	86.0	4.0	295	120	415	23.5	16.5	71.1
1917	3.0	2.9	94	26	120	1.6	92.6	5.5	425	105	530	13.5	13.0	80.2
	4.9	4.3	98	22	120	13.1	90.2	5.5	380	125	505	15.5	13.5	75.2
	6.7	5.3	99	18	117	16.3	91.1	5.0	350	90	440	16.5	13.5	79.5
	10.7	6.3	80	29	109	41.5	79.3	4.0	290	55	345	15.5	14.5	84.1
	12.0	6.3	80	28	108	47.5	78.6	4.3	295	55	350	16.0	14.5	84.3
	19.3	8.3	82	35	117	57.3	92.8	4.8	330	65	395	15.5	14.0	82.2
1918	3.1	3.1	76	30	106	0	16.6	3.3	50	33	83	15.5	12.5	60.0
	4.8	4.7	77	20	97	3.1	61.1	3.5	180	34	214	17.5	10.5	83.3
	7.2	6.2	77	20	97	14.6	84.1	3.5	281	38	319	18.0	13.0	88.2
	10.0	7.6	80	17	97	23.8	75.8	3.5	235	25	260	17.5	11.5	90.4
	12.2	7.8	74	10	84	36.1	67.8	4.0	257	43	300	19.5	15.5	85.7
	19.3	8.4	75	9	84	56.4	75.9	3.8	288	37	325	20.5	16.0	88.5

The annual yields of brush are shown in Table XIV, together with 3-year and 5-year averages, so that comparisons may be made readily between the yields from different rates. These same data are shown again in Table XXI with similar data regarding other methods of spacing, for comparison between methods. Those rates which are comparable for at least three years are shown in Table XIV. Rates that did not differ more than 1 inch in row space per hill in the different years are treated as one rate of seeding. The same is true of the 6 to 7 inch and the 9 to 10 inch stands. The 11 to 14 inch stands are grouped as one rate also, though they cover a larger difference (3 inches) in row space per hill.

TABLE XIV.—*Annual and average acre yields of Acme broom corn in the combined rate-of-seeding and spacing experiments at the Woodward (Okla.) Field Station during periods of varying length in the 5-year period from 1914 to 1918, inclusive.*

[One plant in each hill; rows spaced 3.5 feet apart.]

Distance between hills.	Annual acre yields (pounds).										Average yields.			
	1914		1915		1916		1917		1918		3 years, 1916 to 1918.		5 years, 1914 to 1918.	
	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.
4 to 5 inches...	215	90	775	87	405	65	380	125	180	34	332	75	391	80
6 to 7 inches...	305	60	685	110	531	44	350	90	281	38	387	57	430	68
9 to 10 inches..	250	20	590	75	480	75	290	55	235	25	335	52	369	50
11 to 14 inches.	280	10	735	70	415	90	295	55	257	43	322	63	396	54
18 to 19 inches.	------	------	------	------	295	120	330	65	288	37	304	74	------	------

The highest annual yield of good brush produced in the 5-year period was 775 pounds from the 4 to 5 inch rate in 1915, and the lowest annual yield was 180 pounds from this same rate in 1918. Here it is seen that the rate which yields highest in a favorable season yields lowest in an unfavorable one. Therefore, the most profitable rate is one that makes fair to good yields each year and a fair average yield in a series of years. The highest average yield in both the 3-year and the 5-year periods was made by the 6 to 7 inch rate. This rate averaged 387 pounds of good brush in the 3-year period from 1916 to 1918, inclusive, or 52 pounds more than its nearest competitor. In the 5-year period, from 1914 to 1918, inclusive, the 6 to 7 inch rate averaged 430 pounds of good brush. The next highest was 396 pounds from the 11 to 14 inch rate, or 34 pounds less.

TWO PLANTS PER HILL, ROWS 3.5 FEET APART.

Table XV shows the agronomic data from rows spaced 3.5 feet apart with plants grouped two in each hill in the rate-of-seeding and spacing experiments. In this second section of the experiments each hill contains two plants instead of one, and the hills occupy twice the

row space at the same rate of seeding as they do in the first section. The reaction of the crop under these two methods is quite similar in many ways. While the number of suckers produced increased as the stands decreased, the total percentage of suckers developed under this method is approximately one-third less than developed when the other method of spacing the plants was used. This should tend naturally to increase the percentage of headed stalks, but it is not in proportion to the decrease in the production of suckers. The increase in headed stalks amounts to 5 per cent only, and the decrease in suckers amounts to 35 per cent.

In yield, quality, and length of brush, the reaction of the crop to this method of spacing the hills and plants is quite similar to that of the first method discussed. The response of the crop at the different rates varies with seasonal conditions. The thicker stands usually outyield the other rates in favorable seasons, and the thinner stands give the best results in dry years. At the intermediate rates fair to good yields of good-quality brush are produced in all seasons.

TABLE XV.—*Agronomic data for Acme broom corn in the combined rate-of-seeding and spacing experiments at the Woodward (Okla.) Field Station during the 5-year period from 1914 to 1918, inclusive.*

[Two plants in each hill; rows spaced 3.5 feet apart.]

Year.	Row space (inches).		Length of period (days).			Percentage of—		Height of plants (feet).	Yield of brush per acre (pounds).			Length of brush (inches).		Percentage of good brush.
	Hills.	Stalks.	Vegetative.	Fruiting.	Total.	Suckers.	Headed stalks.		Good.	Poor.	Total.	Good.	Poor.	
1914	6.6	6.6	73	17	90	0	71.3	4.3	225	60	285	18.0	14.0	79.9
	8.2	8.2	73	17	90	0	75.6	4.3	250	100	350	18.0	15.0	71.4
	11.6	11.6	73	17	90	0	79.6	4.0	275	60	335	20.0	15.0	82.1
	17.8	17.8	73	17	90	0	84.3	4.0	365	20	385	24.0	15.0	95.1
	20.0	20.0	73	17	90	0	83.1	4.0	265	25	295	22.0	16.0	91.4
	23.0	23.0	73	17	90	0	86.1	4.0	340	10	350	24.0	15.0	97.1
1915	7.6	7.6	75	16	91	0	80.8	5.8	710	160	870	21.0	19.0	81.6
	10.6	5.0	75	16	91	6.0	91.7	5.8	735	105	840	22.0	20.0	87.5
	11.6	5.5	75	16	91	4.7	92.8	5.8	670	135	805	22.0	20.0	83.2
	17.0	7.3	75	16	91	14.0	91.4	5.8	600	90	690	24.0	22.0	87.0
	19.4	6.2	75	16	91	36.1	91.7	5.8	695	80	775	24.0	22.0	89.7
	28.0	8.0	75	16	91	43.2	97.1	5.8	580	45	625	26.0	24.0	92.8
1916	9.6	4.7	73	14	87	2.0	85.7	4.3	472	39	511	19.5	13.0	82.6
	13.2	6.0	71	16	87	9.7	89.8	4.5	556	50	606	24.0	22.0	91.7
	18.4	7.8	71	14	85	14.8	91.3	4.5	511	44	555	20.5	18.0	92.0
	25.0	8.8	71	14	85	29.7	92.9	4.3	400	100	500	23.0	17.5	80.0
	33.2	13.6	71	12	83	22.4	92.0	4.3	305	56	361	22.5	19.0	84.6
1917	6.0	6.0	96	24	120	0	87.0	5.5	405	100	505	14.5	12.5	80.2
	9.8	4.4	101	19	120	10.9	92.2	5.0	428	50	478	16.0	13.5	89.5
	13.4	6.0	99	18	117	10.5	92.8	5.5	330	122	422	16.5	13.5	71.1
	21.4	8.3	80	29	109	22.6	85.5	4.0	228	45	273	15.0	13.0	83.7
	23.8	8.5	80	28	108	28.7	88.2	4.0	289	39	328	16.5	14.5	88.1
	41.4	12.5	80	28	108	40.3	89.0	4.0	211	22	233	18.0	15.0	90.5
1918	6.2	6.2	76	30	106	0	21.8	3.5	67	39	106	16.5	13.0	61.6
	9.5	9.3	77	20	97	2.9	65.0	3.5	186	64	250	18.0	13.5	74.3
	14.4	13.6	77	20	97	5.3	86.7	3.8	271	29	300	16.5	11.0	90.5
	19.9	17.3	80	17	97	13.4	78.7	3.5	200	22	222	16.5	10.5	90.0
	24.3	19.5	74	10	84	19.8	82.5	4.0	343	14	357	22.5	18.0	96.0
	36.1	25.1	72	12	84	30.0	87.2	4.0	300	21	321	22.5	17.0	93.0

Table XVI shows both the annual and the average acre yields at the rates of seeding specified in Table XV, so far as they are comparable for either the 3-year period from 1916 to 1918, inclusive, or for the 5-year period from 1914 to 1918, inclusive. The highest annual acre yield of good brush produced at any rate was 710 pounds, which was from the thick rate or a stand of 8 to 10 inches of row space to the hill in 1915. The lowest acre yield, 186 pounds, was produced at this same rate in 1918. The highest average yield in both the 3-year and 5-year periods was produced at the rate of seeding with a stand ranging from 12 to 14 inches of row space to the hill. This is approximately the same rate per acre as one plant to the hill with hills spaced 6 to 7 inches apart in the row, which gave the highest average under the first method discussed. The differences between the 5-year average acre yields given in Table XVI are within the limits of experimental error. For a comparison between the methods, the data contained in Table XVI are repeated in Table XXI.

TABLE XVI.—*Annual and average acre yields of Acme broom corn in the combined rate-of-seeding and spacing experiments at the Woodward (Okla.) Field Station during periods of varying length in the five years from 1914 to 1918, inclusive.*

[Two plants in each hill; rows spaced 3.5 feet apart.]

Distance between hills.	Annual acre yields (pounds).										Average yields.			
	1914		1915		1916		1917		1918		3 years, 1916 to 1918.		5 years, 1914 to 1918.	
	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.
8 to 10 inches.	250	100	710	160	472	39	428	50	186	64	362	51	409	83
12 to 14 inches.	275	60	670	135	556	50	300	122	271	29	376	67	414	79
18 to 21 inches.	365	20	695	80	511	44	223	45	209	22	313	37	400	42
23 to 28 inches.	340	10	580	45	400	100	289	39	343	14	344	51	390	42
33 to 41 inches.	.....	.....	.....	.....	305	56	211	22	300	21	272	33	.....	.....

FOUR PLANTS PER HILL, ROWS 3.5 FEET APART.

Table XVII shows the agronomic data in the third section of the combined rate-of-seeding and spacing experiments, in which the plants were grouped four in each hill in rows spaced 3.5 feet apart. This method of spacing has been in use three years, from 1916 to 1918, inclusive, and only two rates were sown each year. In the first or thick rate, the hills varied in row space from 17.6 inches in 1916 to 19.6 inches in 1917. This rate represents approximately the same number of plants per acre as the rate with one plant each in hills spaced from 4 to 5 inches apart in the row, which was considered under the first method of spacing used in these experiments. The second or thinner rate in this method required a row space per

hill varying from 26.8 inches in 1917 to 28.8 inches in 1918, which is equivalent to one plant each in hills spaced approximately 7 inches apart in the row.

TABLE XVII.—*Agronomic data for Acme broom corn in the combined rate-of-seeding and spacing experiments at the Woodward (Okla.) Field Station during the 3-year period from 1916 to 1918, inclusive.*

[Four plants in each hill; rows spaced 3.5 feet apart.]

Year.	Row space (inches).		Length of period (days).			Percentage of—		Height of plants (feet).	Yield of brush per acre (pounds).			Length of brush (inches).		Percentage of good brush.
	Hills.	Stalks.	Vegetative.	Fruiting.	Total.	Suckers.	Headed stalks.		Good.	Poor.	Total.	Good.	Poor.	
1916	17.6	4.1	73	14	87	6.3	87.7	4.3	525	65	590	20.0	17.5	89.0
	28.4	6.4	71	16	87	9.9	90.2	4.5	480	50	530	23.0	18.5	90.6
1917	19.6	4.7	99	21	120	4.0	94.0	5.3	469	25	494	15.5	12.0	94.9
	26.8	6.5	95	21	116	3.5	96.7	5.0	372	72	444	16.5	13.5	83.8
1918	19.1	18.9	77	20	97	1.6	75.3	3.8	256	38	294	15.5	10.5	87.2
	28.8	28.4	75	22	97	1.3	85.3	3.5	242	29	271	18.0	12.5	89.5

The reaction of the crop to this method of grouping the plants appears to be about the same as to the other methods previously considered with regard to the vegetative, fruiting, and total growing periods. A small percentage of suckers was produced at both rates each year, but the average percentage in either rate is much smaller than that of the corresponding rates with single plants in each hill; at the thinner rate a higher percentage of headed stalks was produced each year than at the thick rate, but the highest yield of both good brush and total brush was obtained at the thick rate in all three years. The thinner rate produced the longest average length of brush each year. The annual and 3-year average acre yields are shown in Table XVIII, where comparisons are readily made between these two rates, and these same data are shown again in Table XXI, where comparisons with other methods of spacing are made.

TABLE XVIII.—*Annual and average acre yields of Acme broom corn in the combined rate-of-seeding and spacing experiments at the Woodward (Okla.) Field Station during the 3-year period from 1916 to 1918, inclusive.*

[Four plants in each hill; rows spaced 3.5 feet apart.]

Distance between hills.	Annual acre yields (pounds).						Average yields for the 3 years 1916 to 1918.	
	1916		1917		1918			
	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.
17.6 to 19.6 inches	525	65	469	25	256	38	417	42
26.8 to 28.8 inches	480	50	372	72	242	29	365	50

ONE PLANT PER HILL, ROWS 7 FEET APART.

Table XIX shows the agronomic data from the fourth section of the rate-of-seeding and spacing experiments, in which the hills contained one plant each and the rows were spaced 7 feet apart. This method has been used in the 5-year period from 1914 to 1918, inclusive. It contained six rates of seeding each year except in 1915, when there were only five rates. These rates in most cases are directly comparable with those in the first and second methods considered and shown in Tables XIII and XV, respectively. The total number of plants to the acre is approximately the same at any given rate in all three methods, but they are grouped differently in the rows. In this fourth method the plants stand twice as thick in the rows, but the rows are twice as far apart.

In 1914 the sowings at the six rates presented stands varying in row space per hill or plant from 2.1 inches at the thickest rate to 6.3 inches at the thinnest rate. This was a difference of 4.2 inches of row space per hill between the extreme rates. In 1915 the thickest rate had 2.8 inches of row space to the hill and the thinnest rate 8.1 inches, which was a difference of 5.5 inches between these extremes. There were five rates only in 1915. These represent the extreme rates used in the previous year, but omit one of the intermediate rates. The six rates used in 1917 and in 1918 are approximately the same.

The crop shows no effect on growth on account of the different rates of seeding in this method of spacing the rows under normal seasonal conditions, such as existed in 1914 and 1915. In unfavorable dry seasons, growth was slower at the thick rates than at the thinner ones, which prolongs the vegetative and total growing periods. This was the case in 1917 and 1918, when more time was required to mature by the crop sown at the thick rates than at the thin rates.

The influence the stand has on the production of suckers is illustrated again by this method of spacing the rows and plants. It appears that a stand of about 2 inches of row space to the plant practically eliminates suckering, even in years when conditions are favorable to their growth. The percentage of suckers increases as the stand decreases in all the methods of spacing the plants.

The thin rates in rows spaced 7 feet apart developed a much larger percentage of suckers than was developed in rows spaced 3.5 feet apart having the same number of plants in the row. The stand with 6 inches of row space to the plant in rows spaced 7 feet apart produced an average of 18.3 per cent of suckers in the 4-year period from 1915 to 1918, inclusive, while the 6-inch stand in the rows spaced 3.5 feet apart produced an average of 11.8 per cent. The 9-inch stand in the rows spaced 7 feet apart produced an average of 37.7

per cent of suckers, and in the rows spaced 3.5 feet apart the average was only 27.1 per cent during the same period. However, when the same numbers of plants to the acre are grown in rows spaced 3.5 feet apart and in rows spaced 7 feet apart, the percentage of suckers developed in the rows 3.5 feet apart is materially larger than in the rows 7 feet apart, in which there are twice as many plants to the row. The comparison is made quickly by dividing by 2 the first percentage in each pair given above.

The average percentage of stalks headed is slightly higher in this case than when the method of spacing the rows 3.5 feet apart was used. The height of the plants also averages greater in most of the years when the rows are spaced 7 feet apart.

TABLE XIX.—*Agronomic data for Acme broom corn in the combined rate-of-seeding and spacing experiments at the Woodward (Okla.) Field Station during the 5-year period from 1914 to 1918, inclusive.*

[One plant in each hill; rows spaced 7 feet apart.]

Year.	Row space (inches).		Length of period (days).			Percentage of—		Height of plants (feet).	Yield of brush per acre (pounds).			Length of brush (inches).		Percentage of good brush.
	Hills.	Stalks.	Vegetative.	Fruiting.	Total.	Suckers.	Headed stalks.		Good.	Poor.	Total.	Good.	Poor.	
1914	2.1	2.1	73	17	90	0	74.8	4.5	155	130	285	18.0	15.0	53.7
	2.8	2.8	73	17	90	0	81.0	4.5	275	30	305	20.0	15.0	90.2
	3.2	3.2	73	17	90	0	78.5	4.3	250	30	280	20.0	15.0	89.3
	3.8	3.8	73	17	90	0	81.5	4.3	205	40	245	20.0	15.0	83.7
	4.9	4.9	73	17	90	0	88.0	4.3	225	25	250	23.0	15.0	90.0
	6.3	6.3	73	17	90	0	94.2	4.3	310	15	325	24.0	17.0	95.4
1915	2.8	2.8	75	16	91	0	90.1	5.8	570	85	655	20.0	18.0	87.0
	3.7	3.7	75	16	91	0	96.7	5.8	530	80	610	23.0	21.0	86.9
	5.2	5.2	75	16	91	0	90.0	5.8	390	50	440	24.0	22.0	88.6
	5.4	5.3	75	16	91	1.5	91.6	5.8	485	60	545	24.0	22.0	89.0
	6.3	5.4	75	16	91	14.4	99.4	5.8	463	37	500	25.0	23.0	92.5
	8.1	5.1	75	16	91	36.7	93.1	5.8	465	25	490	26.0	24.0	94.9
1916	2.6	2.6	73	14	87	0	84.7	5.0	456	38	494	20.5	14.5	92.4
	3.7	3.6	71	16	87	2.1	91.4	4.8	438	50	488	23.0	18.5	89.7
	4.6	4.3	71	14	85	4.8	91.6	5.0	400	44	444	23.0	16.0	90.1
	6.4	5.1	71	14	85	20.0	93.9	4.8	363	75	438	25.5	16.5	82.9
	9.2	5.7	71	12	83	38.0	91.0	4.8	300	87	387	24.0	16.5	80.0
1917	1.5	1.5	96	24	120	0	73.6	5.5	130	210	340	15.0	13.0	38.2
	2.5	2.4	94	26	120	1.0	92.4	5.5	325	81	406	16.0	13.5	80.0
	3.4	3.2	87	29	116	5.0	94.2	5.5	312	106	418	17.0	14.0	74.6
	5.4	4.8	78	31	109	10.4	93.1	4.5	244	50	294	16.0	12.5	83.0
	6.0	4.8	78	30	108	20.5	87.1	4.5	231	32	263	15.0	13.0	88.1
	9.7	5.3	78	30	108	45.0	82.9	4.5	220	25	245	17.5	15.0	89.8
1918	1.6	1.6	80	17	97	0	78.2	3.8	155	110	265	17.0	11.5	58.5
	3.1	3.1	73	11	84	0	72.0	4.3	294	37	331	20.0	15.0	88.7
	3.6	3.6	73	11	84	0	67.4	4.3	238	37	275	20.5	14.5	86.4
	5.0	4.6	73	15	88	8.3	75.2	4.0	134	41	175	19.0	15.5	76.8
	6.0	4.9	73	11	84	18.4	80.6	4.5	325	25	350	21.0	16.5	92.9
	9.2	6.3	75	9	84	31.2	78.0	4.3	256	13	269	21.5	16.5	95.4

The reaction of the crop, as shown by yield of brush with this method of spacing, is quite similar to that in the case of the methods already discussed. Under favorable growing conditions the thicker rates give the highest yields, and in less favorable and poor seasons

the thinner stands outyield the others. It is necessary, therefore, to study the average yields for a period of years in order to determine the most profitable rate of seeding and spacing.

The annual and average acre yields are shown in Table XX. It will be noted in this table that rates which show a slight variation in row space per hill in the different years are considered comparable and treated as a single rate. Five rates are presented here. The lowest annual acre yield of good brush was 134 pounds, made at the 4 to 5 inch rate in 1918, and the highest yield was 570 pounds, made with the 2 to 3 inch spacing in 1915. This spacing made the best yield in four out of the five years and gave the highest average in both the 3-year and the 5-year periods. The next highest average in both these periods was from the spacing varying from 3.4 to 3.8 inches. The lowest 5-year average yield was with the 4 to 5 inch spacing, and this rate tied with the 8 to 10 inch spacing for low yield in the 3-year period.

TABLE XX.—*Annual and average acre yields of Acme broom corn in the combined rate-of-seeding and spacing experiments at the Woodward (Okla.) Field Station during periods of varying length in the five years from 1914 to 1918, inclusive.*

[One plant in each hill; rows spaced 7 feet apart.]

Distance between hills.	Annual acre yield (pounds).										Average yield.			
	1914		1915		1916		1917		1918		3 years, 1916 to 1918.		5 years, 1914 to 1918.	
	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.
2 to 3 inches...	275	30	570	85	456	38	325	81	294	37	358	52	384	54
3 4 to 3.8 inches	205	40	530	80	438	50	312	106	238	37	329	64	345	63
4.6 to 5.4 inches	225	25	390	50	400	44	244	50	134	41	259	45	279	42
6 to 6.4 inches.	310	15	463	37	363	75	231	32	375	25	306	44	338	37
8 to 10 inches..	.....	.....	465	25	300	87	220	25	256	13	259	32	.....	.....

COMPARATIVE YIELDS FROM ALL METHODS OF SPACING.

In Table XXI all comparable rates of seeding in the different methods of spacing used in these experiments are presented, so that comparisons may be made easily between the annual and average acre yields from all methods of spacing. Five different rates are represented here, and these are distributed into five groups, each one containing different combinations having the same number of plants per acre. Data given for each group are the distance between the rows in feet, the row space to the hill in inches, the number of plants in each hill, and the annual and average acre yield for each method of spacing.

Group A contains the data for the thick rate in each method of spacing. This rate represents an average of approximately one

plant to 4.5 inches of row space in rows 3.5 feet apart and of one plant to each 2 or 3 inches where the rows were 7 feet apart, or 35,200 plants to the acre. The highest annual yield of good brush, 775 pounds, at this rate was made in 1915, by method 1, with rows spaced 3.5 feet apart and one plant in each hill. This method also made the lowest yield, 180 pounds, in 1918. It has the lowest average yield in the 3-year period from 1916 to 1918, inclusive, and ranks second in the 5-year period from 1914 to 1918, inclusive. The highest average yield in the 3-year period was obtained by the use of the method of grouping four plants in each hill in rows 3.5 feet apart. This method was employed only during that period. The method of spacing the rows 7 feet apart with one plant in each hill gave the highest annual yield in 1914 and in 1918, but it ranks third in average yield in both the 3-year and the 5-year periods.

Group B represents an average of one plant to 6.5 inches of row space where the rows were 3.5 feet apart or half as many inches where the rows were 7 feet apart, or 24,400 plants to the acre. In this rate the first method, spacing one plant in a hill in rows 3.5 feet apart, gave the highest annual yield in three years of the 5-year period and in average yield ranks first in both the 3-year and the 5-year periods. The second method, with two plants in the hill, made the highest yield in only one year, 1916, but it ranks second in average yield in both periods. By the fourth method, or spacing the rows 7 feet apart, much lower yields were made than by any of the others in nearly all years, which gave it a low rank in both periods.

Group C represents a stand of one plant to 9.5 inches of row space in 3.5-foot rows or about 5 inches in rows 7 feet apart, or 16,700 plants to the acre. At this rate, the crop grown in rows spaced 3.5 feet apart gave a much higher yield than when grown in rows spaced 7 feet apart. The second method, or grouping two plants in the hill, gave the highest yield in two years of the 5-year period. This gave the first method the highest average in the 3-year period from 1916 to 1918, inclusive, and the second method the highest average in the 5-year period from 1914 to 1918, inclusive.

Group D has a stand of 12.5 inches of row space to the hill or its equivalent in 7-foot rows, or 12,600 plants to the acre. At this rate, as in the previous one, the crop grown in rows spaced 3.5 apart gave a higher yield than when grown in rows spaced 7 feet apart. The first method, with one plant in the hill, gave the highest yield in three years and ranks first in the 5-year average. The second method, with two plants in the hill, produced the highest yield in two years in the 5-year period and ranks first in the 3-year average.

Group E has an average of 18.5 inches of row space to the plant or its equivalent in 7-foot rows, or 8,500 plants to the acre. This rate

was in use only three years, from 1916 to 1918, inclusive. In that time the first method of spacing, with one plant in each hill in rows spaced 3.5 feet apart, gave the highest yield in one year only; but its average yield in the 3-year period exceeded that of any of the other methods in use.

TABLE XXI.—*Annual and average acre yields of Acme broom corn in the combined rate-of-seeding and spacing experiments at Woodward (Okla.) Field Station in most or all of the five years from 1914 to 1918, inclusive, showing the results obtained at all rates of seeding in all methods of spacing, arranged in five groups, each containing rates having the same number of plants per acre.*

Group A.—AVERAGE OF 1 PLANT TO 4.5 INCHES OF ROW SPACE, OR 35,200 PLANTS TO THE ACRE.

Distance between rows.	Hills.		Annual acre yields (pounds).										Average yields.			
	Spacing (inches).	Plants.	1914		1915		1916		1917		1918		3 years, 1916 to 1918.		5 years, 1914 to 1918.	
			Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.	Good.	Poor.
3.5 feet	4 to 5	1	215	90	775	87	405	65	380	125	180	34	322	75	391	80
3.5 feet	8 to 10	2	250	100	710	160	472	39	428	50	186	64	362	51	409	83
3.5 feet	17.6 to 19.6	4	.....	.....	.....	.....	525	65	469	25	256	38	417	42	.....	.....
7 feet	2 to 3	1	275	30	570	85	456	38	325	81	294	37	358	52	384	54
Group B.—AVERAGE OF 1 PLANT TO 6.5 INCHES OF ROW SPACE, OR 24,400 PLANTS TO THE ACRE.																
3.5 feet	6 to 7	1	305	60	685	110	531	44	350	90	281	38	387	57	430	68
3.5 feet	12 to 14	2	275	60	670	135	557	50	300	122	271	29	376	67	414	79
3.5 feet	26.8 to 28.8	4	.....	.....	.....	.....	480	50	372	72	242	29	365	50	.....	.....
7 feet	3.4 to 3.8	1	205	40	530	80	438	50	312	106	238	37	329	64	345	63
Group C.—AVERAGE OF 1 PLANT TO 9.5 INCHES OF ROW SPACE, OR 16,700 PLANTS TO THE ACRE.																
3.5 feet	9 to 10	1	250	20	590	75	480	75	290	55	235	25	335	52	369	50
3.5 feet	18 to 21	2	365	20	695	80	511	44	228	45	200	22	313	37	400	42
7 feet	4.6 to 5.4	1	225	25	390	50	400	44	244	50	134	41	259	45	279	42
Group D.—AVERAGE OF 1 PLANT TO 12.5 INCHES OF ROW SPACE, OR 12,600 PLANTS TO THE ACRE.																
3.5 feet	11 to 14	1	280	10	735	70	415	90	295	55	257	43	322	63	396	54
3.5 feet	23 to 28	2	340	10	580	45	400	100	289	39	343	14	344	51	390	42
7 feet	6 to 6.4	1	310	15	463	37	363	75	231	32	325	25	306	44	338	37
Group E.—AVERAGE OF 1 PLANT TO 18.5 INCHES OF ROW SPACE, OR 8,500 PLANTS TO THE ACRE.																
3.5 feet	18 to 19	1	.....	.....	.....	.....	295	120	330	65	288	37	304	74	.....	.....
3.5 feet	33 to 41	2	.....	.....	.....	.....	305	56	211	22	300	21	272	33	.....	.....
7 feet	8 to 10	1	.....	.....	465	25	300	87	220	25	256	13	259	32	.....	.....

In summing up the results from the rate-of-seeding and spacing experiments, it is interesting to note that the crop grown in rows spaced 3.5 feet apart gave the highest average yield in all five groups or rates in both the 3-year and the 5-year periods. The first method, with one plant in each hill in rows spaced 3.5 feet apart, gave the highest average yield in groups B, C, and E, or in three of the five

rates in the 3-year period. This method ranked first in groups B and D, or in two of the four rates averaged in the 5-year period. The third method, with four plants in each hill, gave the highest average in group A, or the thick rate, in the 3-year period. The second method, with two plants in the hill, gave the highest average in group D in the 3-year and in groups A and C in the 5-year period. Thus, it is seen that the first method, with one plant in the hill in rows spaced 3.5 feet apart, has more high averages than any other method. This is a good indication that it is the most favorable method of spacing, and also from 6 to 7 inches of row space to the plant appears to be the most profitable rate of seeding, as that is the rate which gave the highest average yield in this experiment and in all other experiments as well.

HARVESTING EXPERIMENTS.

The object of the harvesting experiments was to learn the stage of development at which broom corn should be harvested to obtain the highest yield and quality of cured brush. The experiments were conducted in the seasons of 1915, 1917, and 1918. Acme broom corn (C. I. No. 243) was used in making these experiments.

In 1915 the harvesting experiment was conducted to learn the stage of maturity at which to harvest broom corn to obtain the highest yield of cured brush. Three plats of broom corn, not equal in area, in different stages of development, were harvested. The first lot was in the flower stage, the second in the milk, and the third lot in the dough stage when harvested. Each lot was weighed as soon as harvested, including the seed. Then the heads were thrashed and the brush was put on racks in the shed to cure. After the brush was thoroughly dry the cured weights were obtained.

TABLE XXII.—*Data obtained from the broom-corn harvesting experiment conducted at Woodward, Okla., in 1915.*

Stage of development.	Green brush, including seed.	Cured brush.	Cured brush.
	Pounds.	*Pounds.*	*Per cent.*
Flower	309	79	25.6
Milk	209	59	28.2
Dough	441	142	32.2

The data in Table XXII show that 309 pounds of broom corn harvested in the flower stage yielded 79 pounds of cured brush, which is 25.6 per cent of the total green weight. When harvested in the milk stage, 209 pounds produced 59 pounds of cured brush, or 28.2 per cent of the total green weight. In the dough stage 441

pounds, green weight, produced 142 pounds, or 32.2 per cent of cured brush. From these data it is apparent that broom corn harvested in the dough stage gives a higher percentage of cured brush than when it is harvested at either the flower or milk stage. To obtain the highest yield of cured brush, therefore, broom corn should be allowed to reach the dough stage before it is harvested.

In 1917 the harvesting experiment was conducted on an area of 0.36 of an acre, which was divided into three equal and uniform portions. The broom corn was harvested from one portion of that area in the flower stage, from another in the milk, and from the third portion in the dough stage. Owing to unfavorable growing conditions the crop was nonuniform in heading, which made necessary several successive harvestings to get the heads as they reached the desired stages of maturity. Counts were made of the heads when harvested. Then they were thrashed and put on shelves in the shed to cure. After the brush was cured the dry weights were obtained. From these weights the number of heads to the pound of cured brush was determined for each stage, as shown in Table XXIII.

In 1918 broom corn was harvested at two stages only. Unfavorable climatic conditions prevailed at heading time, which made head development slow and nonuniform, and no harvesting was done at the flower stage. Later, heads were harvested in both the milk and dough stages of development. These lots were harvested on the same day and from the same rows of broom corn, as both stages were present at the same time. After harvest the experiment was conducted the same as in 1917. The 1918 results are shown in Table XXIII.

The results from the experiment in all three years tend to show rather conclusively that the highest yield of cured brush will be obtained when harvest is delayed until the seeds are in the dough stage.

TABLE XXIII.—*Data from the broom-corn harvesting experiments conducted at the Woodward (Okla.) Field Station in the seasons of 1917 and 1918.*

Year and stage of development.	Heads harvested.	Cured brush.	
		Total.	Heads per pound.
Season of 1917:	*Number.*	*Pounds.*	*Number.*
Flower	3,549	53.0	67.0
Milk	3,472	60.5	57.4
Dough	3,200	58.5	54.7
Season of 1918:			
Milk	811	18.3	44.3
Dough	546	15.6	35.0

WEARING QUALITY OF THE BRUSH.

Brooms were made from the lots of brush harvested at the different stages of maturity in 1917 and 1918, in order to test the wearing quality of the brush. These brooms were divided into sets and are being used for sweeping both private dwellings and office buildings. Each set contains one broom made of brush harvested at the different stages of maturity.

This part of the harvesting experiment has not progressed far enough as yet to draw final conclusions. However, the indications are that the brush harvested in the dough stage will give the best service. When harvested at the earlier stages, the fibers are too weak at the base to stand hard usage. They break over the shoulders of the broom.

NURSERY EXPERIMENTS.

The objects of the broom-corn nursery were to learn the quality of the seed from commercial sources and to obtain stock for subsequent breeding. In the spring of 1915 thirty-four lots of broom-corn seed were obtained from commercial sources and a row 132 feet long was sown with each lot of seed. Nearly all lots of seed were received under some varietal name which indicated whether the seed was of the Standard or of the Dwarf variety. In a few cases the names were misleading, as the same name was applied to both varieties. In other cases the word Dwarf was part of the name used for the Standard variety, or Standard was used in combination with other words for the Dwarf variety. Each lot of seed was given a Cereal Investigations number (C. I. No.).

The commercial name, Cereal Investigations number, and source of all the lots of broom corn grown in the nursery in part or all of the four years from 1915 to 1918, inclusive, are shown in Table XXIV. It will be noted in this table that the seed came from 14 different States and from several different localities in some of these States. One lot came from France, one from Germany, and one from the Greek exhibit at the Panama-Pacific Exposition.

HEIGHT OF PLANTS AND DURATION OF VEGETATIVE PERIOD.

Table XXV shows the height of the plants (in feet) and the duration of the vegetative period (in days) for all lots of broom corn grown in the nursery in part or in all of the years from 1915 to 1918, inclusive, with 4-year averages. The height of Standard broom corn ranged from 7 to 11 feet in 1915. In the less favorable seasons of 1916, 1917, and 1918 the plants averaged much lower in height than in the favorable season of 1915. Dwarf broom corn reached a height of 5 to 6 feet in 1915, but in 1918 the height ranged from 2.8 to 4.3 feet only.

TABLE XXIV.—*Commercial names, Cereal Investigations numbers, and sources of the different lots of broom corn grown in the nursery at the Woodward (Okla.) Field Station in part or all of the four years from 1915 to 1918, inclusive.*

Commercial name.	C. I. No.	Source.
Standard:		
Standard broom corn	446	Oakland, Ill.
Do	556	Linsday, Okla.
Do	560	Paris, France.
European sorghum	561	Sherman, Tex.
Broom corn	563	Springfield, Mo.
Standard Evergreen	565	Houston, Tex.
California Golden Dwarf	580	Do.
California Golden	582	Lawrence, Kans.
Improved Evergreen	583	Dallas, Tex.
Do	584	Ravenna, Ohio.
Do	585	Richmond, Va.
Do	586	Lawrence, Kans.
Tennessee Evergreen	587	Do.
Evergreen	588	New York, N. Y.
Do	589	Des Moines, Iowa.
Do	590	Chicago, Ill.
Missouri Evergreen	591	Kansas City, Mo.
Longbrush Evergreen	592	New York, N. Y.
Evergreen	593	Milwaukee, Wis.
Do	594	Birmingham, Ala.
Mammoth Dwarf	600	Wichita, Kans.
Improved Evergreen	602	Denver, Colo.
Evergreen	603	Lincoln, Nebr.
Dwarf Evergreen	604	Los Angeles, Calif.
Broom corn	607	Greek Exhibit, Panama-Pacific Exposition.
Dwarf.		
Acme	243	Amarillo, Tex.
Whisk Dwarf	442	Sterling, Kans.
Dwarf broom corn	535	Amarillo, Tex.
Evergreen Dwarf	557	Elk City, Okla.
Dwarf broom corn	558	Carignan, Ardennes, France.
Do	559	Erfurt, Germany.
European sorghum	562	Sherman, Tex.
Standard Evergreen	564	Wichita, Kans.
California Golden	581	Des Moines, Iowa.
Oklahoma Dwarf	595	Lawrence, Kans.
Do	596	Kansas City, Mo.
Dwarf	597	Dallas, Tex.
Do	598	Des Moines, Iowa.
Do	599	New York, N. Y.
Do	601	Denver, Colo.
Broom corn	605	Bard, Calif.
Do	606	Do.

The duration of the vegetative period with Standard broom corn shows a difference of 20 days between the earliest and latest maturing lots in 1915, which increased to 34 days in 1918. The variation in the vegetative period between the different lots of Dwarf broom corn was 19 days in 1915, which was increased to 44 days in 1918.

ROW SPACE AND PERCENTAGE OF SUCKERS.

The row space per plant in inches and the percentage of suckers, of stalks headed, and of good heads, with 2-year averages, for each lot of broom corn grown in the nursery during the two years 1917 and 1918 are shown in Table XXVI. It will be noted that a uniform stand of about 7 inches of row space to the plant was obtained in nearly all the lots in 1917, and that, with a few exceptions, the same uniformity existed in the stand in 1918.

TABLE XXV.—*Height and duration of vegetative period with 4-year averages for each lot of broom corn grown in the nursery at Woodward (Okla.) Field Station during the 4-year period from 1915 to 1918, inclusive.*

Variety and lot (C. I. No.).	Height (feet).				4-year average, 1915 to 1918.	Growing period (days).[1]				4-year average, 1915 to 1918.
	1915	1916	1917	1918		1915	1916	1917	1918	
Standard:										
446	9.0	7.0	7.0	6.0	7.3	83	72	100	77	83
556	.....	7.5	6.5	6.3	.....	.....	71	101	80	.....
560	10.0	6.8	7.5	5.5	7.5	93	81	112	88	93
561	11.0	7.0	8.0	7.3	8.3	96	86	114	98	98
563	11.0	6.5	8.0	6.5	8.0	93	87	116	106	100
565	10.0	7.0	6.5	5.8	7.3	82	76	105	85	87
580	9.0	6.5	6.0	5.5	6.8	79	68	89	70	77
580-2	.....	.....	6.0	.....	.....	.....	.....	89	.....	.....
582	9.0	7.0	6.0	.....	.....	79	70	105	.....	.....
582-2	.....	7.0	6.0	5.5	6.9	.....	68	105	75	82
583	9.0	8.0	6.5	6.3	7.5	77	73	94	77	80
584	10.0	7.5	7.0	6.0	7.9	81	81	112	94	92
585	10.0	7.3	7.0	.....	.....	79	76	104	.....	.....
586	9.0	.....	.....	.....	.....	88	.....	.....	.....	.....
587	9.0	8.0	8.0	.....	.....	77	83	112	.....	.....
588	8.0	7.5	6.0	.....	.....	77	70	94	.....	.....
589	9.0	8.0	8.0	.....	.....	80	76	112	.....	.....
590	7.5	.....	.....	.....	.....	76	.....	.....	.....	.....
591	8.0	7.5	7.0	6.0	7.1	76	70	105	80	83
592	8.0	8.0	7.0	.....	.....	77	69	104	.....	.....
593	8.0	7.5	6.5	6.0	7.0	77	76	97	85	84
594	8.0	8.0	7.0	6.3	7.3	77	74	100	78	82
600	8.0	8.0	7.0	.....	.....	81	72	104	.....	.....
602	8.0	8.0	6.0	7.0	7.3	77	70	94	77	79
603	7.5	.....	.....	.....	.....	76	.....	.....	.....	.....
604	11.0	7.5	7.0	6.5	8.0	76	83	112	89	95
607	.....	7.0	6.0	.....	.....	.....	71	109	.....	.....
Dwarf:										
243	.....	4.8	5.0	3.5	.....	.....	71	93	74	.....
442	.....	3.3	3.5	2.8	.....	.....	76	94	73	.....
535	.....	5.0	5.0	3.5	.....	.....	70	91	73	.....
557	.....	5.3	5.0	3.5	.....	.....	70	96	74	.....
558	5.0	4.8	5.5	4.3	4.9	96	93	111	109	102
559	5.0	5.0	5.5	4.0	4.9	96	87	115	108	102
562	6.5	.....	.....	.....	.....	76	.....	.....	.....	.....
564	6.0	5.3	4.8	3.8	5.0	83	70	102	72	82
581	5.3	.....	.....	.....	.....	80	.....	.....	.....	.....
595	6.0	5.0	4.5	3.3	4.7	81	69	95	72	79
596	5.5	5.0	4.5	3.5	4.6	80	63	93	75	79
597	6.0	5.5	4.5	3.5	4.9	84	70	105	72	83
598	6.0	5.5	5.0	3 5	5.0	81	74	105	74	84
599	6.0	5.5	5.0	3.5	5.0	81	76	112	75	86
601	5.8	.....	.....	.....	.....	77	.....	.....	.....	.....
605	.....	5.0	5.5	4.0	.....	.....	91	114	116	.....
606	.....	4.5	5.5	.....	.....	.....	93	119	.....	.....

[1] The vegetative period extends from the date of seeding to the date when heads apparently cease to appear.

The tendency to sucker is present in both the Standard and Dwarf varieties, but to a much greater degree in some lots than in others. The percentage of suckers in most of the lots did not vary greatly in the two years recorded. However, a few lots in each variety show a wide variation. Standard broom corn (C. I. No. 580) developed 34.3 per cent of suckers in 1917 and only 5.5 per cent in 1918. The highest percentage of suckers developed in Dwarf broom corn was 46.3 per cent by C. I. No. 595 in 1917. This same lot produced only 30.1 per cent in 1918.

PERCENTAGE OF HEADS AND QUALITY OF BRUSH.

In 1917 the Standard broom corn grown in the nursery ranged in the proportion of stalks headed from 73.5 per cent for C. I. No. 580 to 93.4 per cent for C. I. No. 561, with an average of about 74 per cent

for all lots. The percentage of good brush that year was quite low, ranging from less than 1 per cent in several lots to as high as 24.4 per cent in one lot only. Good brush as considered in this experiment includes those heads which have uniformly long, round fiber full and even at the tip and evenly attached to the peduncle at the base. These heads are suitable for the improvement of the strain. In 1918 there was a slight increase in the percentage of good brush over that of the previous year, as shown in Table XXVI.

TABLE XXVI.—*Row space per plant, the percentage of suckers, of headed stalks, and of good heads for each lot of broom corn grown in the nursery at the Woodward (Okla.) Field Station during the two years 1917 and 1918, with the 2-year averages.*

Variety and lot (C. I. No.).	Row space per plant (inches).			Suckers (per cent).			Percentage of stalks headed.			Percentage of good heads.[1]		
	1917	1918	2-year average, 1917 and 1918.	1917	1918	2-year average, 1917 and 1918.	1917	1918	2-year average, 1917 and 1918.	1917	1918	2-year average, 1917 and 1918.
Standard:												
446	7.6	7.1	7.4	6.7	5.1	5.9	85.6	86.0	85.8	7.8	87.1	47.5
556	6.8	6.8	6.8	6.8	5.3	6.1	81.5	83.4	82.5	6.4	87.8	47.1
560	7.3	6.4	6.9	5.2	9.5	7.4	89.0	58.1	73.6	3.9	94.3	49.1
561	7.0	12.2	9.6	7.7	17.7	12.7	93.4	55.0	74.2	24.4	95.4	59.9
563	8.4	8.0	8.2	6.9	7.0	7.0	90.1	55.6	72.9	21.8	71.4	46.6
565	7.0	6.8	6.9	9.3	6.4	7.9	87.1	80.2	83.7	6.0	81.5	43.8
580	7.9	6.6	7.3	34.3	5.5	19.9	73.5	90.1	81.8	3.1	78.1	40.6
580–2	8.0	.....	.....	29.3	.....	.....	74.6	.....	.....	4.3	.....	.....
582	6.7	.....	.....	4.4	.....	.....	89.8	.....	.....	.....	.....	.....
582–2	7.3	7.8	7.6	16.9	15.1	16.0	82.3	84.8	83.6	3.2	79.2	41.2
583	8.0	12.9	10.5	30.9	12.9	21.9	75.7	86.6	81.2	18.3	87.9	53.1
584	7.4	6.8	7.1	7.7	7.5	7.6	82.8	52.3	67.6	6.2	93.9	50.1
585	7.4	.....	.....	7.7	.....	.....	87.0	.....	.....	.9	.....	.....
587	8.6	.....	.....	13.6	.....	.....	82.6	.....	.....	1.1	.....	.....
588	7.3	.....	.....	6.9	.....	.....	89.6	.....	.....	.5	.....	.....
589	7.0	.....	.....	4.7	.....	.....	91.1	.....	.....	.5	.....	.....
591	7.3	6.7	7.0	13.5	4.9	9.2	83.3	84.2	83.8	5.7	82.2	44.0
592	7.2	.....	.....	9.4	.....	.....	72.1	.....	.....	.6	.....	.....
593	7.6	7.0	7.3	3.7	5.4	4.6	84.3	87.0	85.7	7.1	77.8	42.5
594	7.5	7.3	7.4	4.9	3.1	4.0	79.3	90.5	84.9	7.3	82.1	44.7
600	7.0	.....	.....	5.0	.....	.....	78.5	.....	.....	3.2	.....	.....
602	7.6	7.4	7.5	4.6	8.5	6.6	89.0	88.4	88.7	4.6	84.0	44.3
604	7.4	7.0	7.2	9.3	15.1	12.2	79.1	64.9	72.0	8.0	92.4	50.2
607	7.4	.....	.....	7.4	.....	.....	79.1	.....	.....	1.6	.....	.....
Dwarf:												
243	7.6	7.8	7.7	17.1	18.8	18.0	95.6	85.2	90.4	25.4	87.7	56.6
442	8.0	7.9	8.0	29.8	15.9	22.9	92.5	87.8	90.2	16.8	80.4	48.6
535	7.0	7.4	7.2	10.0	18.9	14.5	94.0	78.4	86.2	19.9	80.7	50.3
557	6.3	6.6	6.5	3.1	6.3	4.7	95.3	89.3	92.3	11.8	92.5	52.2
558	7.3	14.5	10.4	4.0	12.1	8.1	93.3	56.4	74.9	7.5	40.0	23.8
559	6.9	6.5	6.7	3.0	.....	1.5	90.3	65.6	78.0	2.8	81.9	42.4
564	8.0	7.0	7.5	15.3	4.6	10.0	95.7	89.0	92.4	15.5	77.2	46.4
595	6.8	7.0	6.9	46.3	30.1	38.2	87.1	76.4	81.8	16.9	96.7	56.8
596	6.6	7.7	7.2	5.2	14.9	10.1	95.2	81.4	88.3	24.1	89.8	56.9
597	7.0	7.3	7.2	11.1	9.2	10.2	97.2	88.9	93.1	18.3	86.8	52.6
598	7.0	7.2	7.1	8.5	13.8	11.2	94.3	81.9	88.1	6.8	93.2	50.0
599	6.6	7.2	6.9	5.5	12.4	9.0	92.8	74.5	83.7	12.7	93.0	52.9
605	6.6	14.3	10.5	2.0	24.5	13.3	93.0	74.8	83.9	4.8	68.1	36.5
606	6.4	.....	.....	5.0	.....	.....	90.8	.....	.....	3.3	.....	.....

[1] Good heads as considered in the nursery work were heads whose conformation was near enough perfect to be used as seed for propagation or for the improvement of the strain.

Dwarf broom corn had a much higher average percentage of stalks headed and a somewhat higher average of good brush in 1917 than the Standard. In 1918 Dwarf broom corn led the Standard in both the average percentage of stalks headed and of good brush, but with

a smaller margin than in 1917. This experiment has not been carried far enough to draw final conclusions, but it is very evident that progress is being made in the development of strains of broom corn which produce a uniform brush.

CONCLUSIONS.

The conclusions drawn from the data presented in this bulletin are as follows:

(1) All varieties of broom corn produce high yields in seasons which are favorable, but only adapted varieties yield well in the less favorable seasons.

(2) Dwarf broom corn outyields the Standard variety under such conditions as obtain at Woodward, Okla.

(3) Dwarf broom corn evidently requires less water than the Standard variety and therefore is better adapted to the conditions which prevail in the district described in this bulletin.

(4) The commercial names applied to broom corn have little significance, as they do not represent distinct varieties.

(5) The tendency to sucker is present in both the Standard and the Dwarf varieties of broom corn, but to a greater degree in the Dwarf. Suckering is influenced largely by environing conditions.

(6) Environing conditions also influence the length and quality of the brush. Thick stands tend to produce short brush and thin stands long, coarse brush.

(7) The best time to sow the crop appears to be either from about May 1 to 15 or from June 15 to 30. When sown at these times the crop comes into head either before or not until after the middle of August, which is usually dry and hot.

(8) No single rate of seeding will give the best results in all years. A stand of one plant to 6 or 8 inches of row space, with rows 3.5 feet apart, appears to be the most profitable rate for a series of years.

(9) There is nothing gained by the method of spacing the rows 7 feet apart with the plants twice as thick in the row as when the rows are spaced half that distance apart.

(10) When harvesting is delayed until the seeds have reached the dough stage a higher yield of brush will be obtained than if harvested earlier.

(11) The indications are that better service will be obtained from brooms made from brush harvested when the seeds are in the dough stage than if harvested at any other time.

(12) The nursery work shows that much of the seed from commercial sources is of poor quality. Progress is being made in developing strains which produce a uniform quality of brush.

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